PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY,

HELD AT PHILADELPHIA, FOR PROMOTING USEFUL KNOWLEDGE.

VOL. XX. JUNE TO DECEMBER, 1882. No. 112.

TABLE OF CONTENTS.

PAGE.

Contribution to a monograph of the North American SYRPHIDÆ. By *Dr. S. W. Williston*..... 299

Stated Meeting, June 16..... 332

Radiant heat an exception to the second law of thermodynamics. By *H. T. Eddy, Ph.D.*..... 334

Revision of the DERMESTIDÆ of the United States. By *Horace F. Jayne, M.D., (with 4 plates)*..... 343

Stated Meeting, July 21..... 378

Stated Meeting, August 18..... 379

Contributions from the laboratory of the University of Pennsylvania, No. XX. By *F. A. Genth*..... 381

Stated Meeting, September 15..... 405

Photodynamic notes, No. VI. By *Pliny Earle Chase, LL.D.*..... 406

The Classification of Ungulate Mammalia. By *E. D. Cope*..... 438

Third Contribution to the history of the Vertebrata of the Permian formation of Texas. By *E. D. Cope*..... 447

Synopsis of the Vertebrata of the Puerco Eocene epoch. By *E. D. Cope*..... 461

On the Systematic relations of the Carnivora FISSIPEDIA. By *E. D. Cope*..... 471

Stated Meeting, October 6..... 475

Stated Meeting, October 20..... 476

Note on the Geology of West Virginia. By *I. C. White*..... 479

Stated Meeting, November 3..... 496

Minute of the Bi-Centennial Anniversary of October 28, 1682. By the President of the Society..... 497

Obituary Notice of Ralph Waldo Emerson. By *Charles G. Ames*.. 498

Stated Meeting, November 17..... 503

Stated Meeting, December 1..... 505

Report of Special Committee on Documents of the Society..... 506

Stated Meeting, December 15..... 509

The horizon of the South Valley Hill rocks in Pennsylvania. By *Persifor Frazer, D.S.*..... 510

Obituary Notice of Edouard Desor. By *J. P. Lesley*. (*To be continued in No. 113.*)..... 519

EXTRACT FROM THE BY-LAWS.

CHAPTER XII.

OF THE MAGELLANIC FUND.

SECTION 1. John Hyacinth de Magellan, in London, having in the year 1786 offered to the Society, as a donation, the sum of two hundred guineas, to be by them vested in a secure and permanent fund, to the end that the interest arising therefrom should be annually disposed of in premiums, to be adjudged by them to the author of the best discovery, or most useful invention, relating to Navigation, Astronomy, or Natural Philosophy (mere natural history only excepted); and the Society having accepted of the above donation, they hereby publish the conditions, prescribed by the donor and agreed to by the Society, upon which the said annual premiums will be awarded.

CONDITIONS OF THE MAGELLANIC PREMIUM.

1. The candidate shall send his discovery, invention or improvement, addressed to the President, or one of the Vice-Presidents of the Society, free of postage or other charges; and shall distinguish his performance by some motto, device, or other signature, at his pleasure. Together with his discovery, invention, or improvement, he shall also send a sealed letter containing the same motto, device, or signature, and subscribed with the real name and place of residence of the author.

2. Persons of any nation, sect or denomination whatever, shall be admitted as candidates for this premium.

3. No discovery, invention or improvement shall be entitled to this premium, which hath been already published, or for which the author hath been publicly rewarded elsewhere.

4. The candidate shall communicate his discovery, invention or improvement, either in the English, French, German, or Latin language.

5. All such communications shall be publicly read or exhibited to the Society at some stated meeting, not less than one month previous to the day of adjudication, and shall at all times be open to the inspection of such members as shall desire it. But no member shall carry home with

Syrphidæ, by Dr. S. W. Williston," was presented through the Secretary, with a letter from the author, dated New Haven, Yale College Museum, May 12, 1882.

"The Classification of the Ungulate Mammalia" was read by Prof. Cope.

New nominations, Nos. 959, 960, 961, were read.

The President reported that he had forwarded a memorial to the President of the New York Senate, in favor of the completion of the Palæontology of New York.

Power was given to the Hall Committee to procure a copy of the portrait of Dr. Geo. B. Wood; and the President was empowered to fill the vacancy caused by the death of Sol. W. Roberts, a member of that Committee.

Authority was given the Librarian to purchase Vols. I–XII Transactions of the American Philological Association.

And the meeting was adjourned.

Contribution to a Monograph of the North American Syrphidæ. By Dr. S. W. Williston.

(*Read before the American Philosophical Society, May 19, 1882.*)

The Syrphidæ form one of the most difficult families of Diptera to classify. Although composed throughout the world of about one hundred and forty described genera, they present no characters that will decisively distinguish any considerable number. As a natural result, many genera have been loosely formed and more loosely described, until the difficulty in identifying species without the aid of numerous types has become extremely great. The present paper is the result of many hours tedious labor in identifying a considerably large amount of material wholly without the aid of types. Prepared two or three years ago it has been rewritten and changed many times; that it is free from error yet I do not presume to hope, but from my own experience in the difficulties that are met with in working with the aid of books alone, I believe that it will materially aid in the study of our species.

In Osten Sacken's catalogue of American Diptera—a work indispensable to all entomologists—fifty-seven genera are recorded as having been creditably recognized from North America. *Toxomerus* of Macquart I have

resuscitated, and have also recognized an interesting new species of *Senogaster* Mac., hitherto known only from South America. Since the publication of the catalogue four new genera have been described by M. Bigot and the writer, making in all sixty-two genera now known from North America. As regards the distribution of these genera twelve are peculiar to our fauna, viz: *Eupeodes*, *Copestylum*, *Hadromyia*, *Eugeniamyia*, *Eurhinamallota*, *Teuchocnemis*, *Pterallastes*, *Polydonta*, *Crioprora*, *Somula*, *Merapioidus*, and *Mixogaster*. The first four of these, with *Catabomba*, have never yet been found in the Eastern States, while the following are not yet known west of the one hundredth meridian, viz: *Triglyphus*, *Pyrophæna*, *Doros*, *Ocyptamus*, *Rhingia*, *Teuchocnemis*, *Pterallastes*, *Senogaster*, *Somula*, *Temnostoma*, and *Milesia*. Of these no doubt the distribution will yet be found more extensive. Indeed the wide distribution of species and genera of the family over our continent will not readily be paralleled by any other family of insects.

In the present paper I have given a list of all the described species known west of the one hundredth meridian. These with the species described as new, reach yet but eighty-six; of them fifty-four are known only from the West, while thirty-two, or over one-third, are distributed from the Atlantic to the Pacific regions.

Five genera, of one or two species each, namely: *Triglyphus*, *Pyrophæna*, *Copestylum*, *Arctophila*, and *Pterallastes*, are unknown to me; their systematic positions have in consequence been wholly drawn from descriptions and figures. They, together with such species as are unknown to me, are preceded by an asterisk. An exclamation point indicates that the locality, or localities, preceding it are given from specimens that I have examined. It has not been deemed necessary to repeat any of the bibliographical references or synonomy that are given in Osten Sacken's catalogue, except such as will facilitate the identification of species. The specimens which I have examined in the preparation of this paper, from Washington Territory, Oregon, and Kern County, California, were collected by Mr. H. K. Morrison; from Mendocino county, California, by Mr. O. T. Baron, and from Wyoming, Colorado, and Kansas, by Mr. E. W. Guild and myself. The species that I have identified, or described, or that have been previously recorded from the West, are printed in small capitals.

I desire to express my thanks to Mr. W. H. Patton and Drs. G. H. Horn and H. A. Brous, for kind favors in the preparation of this paper. To Baron C. R. von Osten Sacken, of Heidelberg, I am much indebted for his kindly interest and advice.

The following table of generic groups is based essentially upon that of Schiner's in his Austrian Diptera. It seems impossible to improve its general features so far as our American genera are concerned.

Table of groups of genera.

Δ.—**Small cross-vein of the wing distinctly before the middle of the** discal cell, usually straight and rectangular. Hind femora usually slender, not thickened; the third longitudinal vein rarely much bent into the first posterior vein, usually straight or very gently curved.
1—Antennæ longer than the head..... I.
2—Antennæ as long or shorter than the head.
a—Marginal cell open, *i. e.*, the second longitudinal vein terminates in the border of the wing.
a—Face not tuberculate, nor distinctly carinate; not excavated below the antennæ in profile; hyperstoma not produced. (Small, nearly bare species, with short oval abdomen)..... II.
aa—Face tuberculate, or hyperstoma produced.
*—Abdomen in outline, linear or oval, never narrowed toward the base, or club-shaped. (Tegulæ of usual size.)
†—Body uniform metallic green, or metallic green and black; abdomen oval or elongate, never slender; femora not thickened, nor facial tubercle dissimilar in male and female. III.
††—Black with luteous, reddish or yellow, when uniformly black the hind femora thickened..... IV.
†††—Black or greenish black, with yellow or yellowish stripes or bands, or face more or less yellow.
§—Face black, abdomen slender, with yellow or greenish yellow interrupted cross-bands..... V.
§§—Face partly or wholly yellow, abdominal markings yellow.
π—Dorsum of thorax with yellow lateral stripes.... VI.
ππ—Dorsum of thorax without yellow lateral stripes. VII.
**—Abdomen contracted toward the base, more or less club-shaped VIII.
aa—Marginal cell closed and petiolate..... IX.
ΔΔ—**The small cross-vein at or beyond the middle of the discal cell,** *i. e.*, the discal section of the fourth longitudinal vein beyond the small cross-vein, is but little longer or much shorter than the section before it; small cross-vein nearly always oblique, the posterior femora frequently thickened.
a—Antennæ with a distinctly dorsal bristle.
β—Third longitudinal vein bent deeply into the first posterior cell
γ—Marginal cell closed and petiolate..... X.
γγ—Marginal cell open..... XI.
ββ—Third longitudinal vein gently curved.
δ—Arista plumose.
ε—Marginal cell closed..... IX.
εε—Marginal cell open..... XII.
δδ—Arista bare or pubescent..... XIII.
aa—Antennæ with a subterminal bristle or terminal style..... XIV.

I.

Δ.—Small cross-vein before the middle of the discal cell.
1. Antennæ longer than the head.

A.—Scutellum flattened, with two obtuse points; face evenly rounded, pubescent, without tubercle; eyes separated in both sexes, narrowly in the male; first posterior cell with a stump of a vein from the third longitudinal; dark or black species, unrelieved by light markings..... **Microdon.**

MICRODON sp. nov. ? Washington Territory, California !

This is the first time this genus has been recorded from the Pacific coast; eight or nine species are known from the eastern part of the continent.

AA.—Scutellum without points; third antennal joint elongate; face produced downward, obtusely tuberculate, yellow with black median stripe; dorsum of thorax with lateral, yellow, interrupted stripes; abdomen oval, arched, with yellow bands; eyes pubescent, **Chrysotoxum.**

This is one of those genera of Syrphidæ, whose species are hard to distinguish and require much material to satisfactorily study.

CHRYSOTOXUM (?) DERIVATUM Walk., Washington Territory; Mt. Hood, Oregon. Apparently a common species. The femora are mostly black, and the lateral margins of the abdomen yellow, otherwise it agrees with *C. laterale* Lw., Cent. v, 42.

II.

A.—Small cross-vein before the middle of discal cell.
1.—Antennæ as long or shorter than the head.
a.—Marginal cell open.
a.—Face without turbercle or hyperstoma not produced.

B.—Abdomen of only four apparent segments; very small species (2–5 mm.) black or greenish black, the ground color unrelieved by lighter spots, stripes or bands.....***Triglyphus.**
BB.—Abdomen of from five to seven segments; third joint of antennæ oblong.
C.—Face evenly rounded, not at all projecting in outline (hind femora moderately swollen); face dark without yellow.....**Pipiza.**

A single species of this genus is recorded by Osten Sacken (West. Dipt. p. 322) from Sonoma Co., Cal. In Europe the species are very numerous.

CC.—Face slightly carinate below, partly or wholly yellow, eyes pilose, in life usually with bright stripes (small, mostly finely punctulate; abdomen oval, obtusely rounded behind, black or black and red, not banded).....**Paragus.**

The species of this genus like the preceding are very difficult to satisfactorily distinguish. Three species are recorded from the Eastern States and I have at least three more yet unnamed from the Pacific regions.

PARAGUS DIMIDIATUS Lw., Cent. iv, 63. Western Kansas, Colorado !

III.

A.—Small cross-vein before the middle of discal cell.
1.—Antennæ as long or shorter than the head.
a.—Marginal cell open.
aa.—Face tuberculate, or hyperstoma produced.
*.—Abdomen oval, never narrowed toward the base, or club-shaped.
†.—Uniform metallic green, metallic green and black, or black species; hind femora never swollen.

D.—False vein of wing usually indistinct or absent; front in ♀, or face also (♂♀) with transverse wrinkles; hind border of scutellum sharp; small, oval, metallic, nearly bare species.....**Chrysogaster.**

a.—Outer posterior angle of first posterior cell obtuse. *Chrysogaster.*
aa.—Outer posterior angle of first posterior cell rectangular or acute.....*Orthoneura.*

The character given is that usually taken as the distinction between the two genera, but is very unreliable and misleading, and, moreover, separates closely related species; the length of the antennæ is equally unreliable; I place all the species in Meigen's genus. There are sufficient plastic characters to render the tabulation and identification of our species a comparatively easy matter. At all events, it is evident that *Orthoneura* cannot be used in Loew's or Schiner's sense even as a sub-genus for the North American species.

Our species may be tabulated as follows:

a.—Third joint of antennæ ovate or orbicular.....*b.*
—Third joint of antennæ elongate.....*e.*
b.—Third joint of antennæ ovate.....*c.*
—Third joint of antennæ orbicular.....*d.*
c.—Dorsum of thorax opaque black (♂).....**nigripes.*
—Dorsum of thorax not black opaque, with dark stripes; finely punctulate; tip of fourth vein bent inwards.....*nigrovittatus.*
d.—Outer posterior angle of first posterior cell not obtuse.....*latus.*
—Outer posterior angle of first posterior cell obtuse.....*ustulatus.*
e.—The ultimate section of fourth longitudinal vein joins the third beyond the tip of second vein, the dark clouds not continuous nor in the same line; second joint of antennæ nearly as long as third; eyes with distinct linear markings; posterior borders of second and third abdominal segments brown.....*nitidus.*
—Ultimate segment of fourth vein joins the third opposite or before tip of second, abdomen not fasciate.....*f.*
f.—Cloud from tip of second vein continuous or in same line with ultimate section of fourth vein; eyes with markings; second joint of antennæ nearly as long as third.....*bellulus*, sp. nov.
—Second joint of antennæ considerably shorter than third, abdomen shining brassy on the sides, the disc more or less opaque; eyes nearly unicolorous; stigma brown.....*g.*
g.—Second joint of antennæ half as long as third; the third joint somewhat narrowed beyond the middle.....*pictipennis.*
—Antennæ not longer than the face, second joint short....*stigmatus*, sp. nov.

CHRYSOGASTER STIGMATUS, sp. nov.

♂♀. Antennæ black, not longer than the face, first joint short, second joint twice as long, about one-fourth as long as third. Face deep green, shining, nearly smooth, with sparse pile, and a silvery white triangular

spot on each side near the eye above; hyperstoma much projecting. Frontal triangle (♂) swollen, distinctly fossulate, front (♀) with well marked lateral grooves. Eyes uniform. Thorax and scutellum shining green, finely punctulate, with obscure pile. Abdomen broad, black, with short appressed white pile, but little shining, in the male the entire margin with the hypopygium shining brassy green, the venter shining like the border. Wings fuscous, stigma brown, outer anterior angle of first posterior cell obtuse. Legs black. Long. corp. 6–7 mm. California.

CHRYSOGASTER BELLULUS, sp. nov.

♂♀. Antennæ reddish-brown, a little longer than the face, second joint a little shorter than third. Face green black, lightly rugose, white pilose, hyperstoma moderately produced downward. Frontal triangle (♂) not swollen, front (♀) with well marked lateral rugosities, eyes with irregular narrow linear markings. Thorax and scutellum bright green, scabrous, with four narrow coppery stripes. Abdomen oval, a little darker green, more shining on the borders, punctulate. Legs black, base and tips of all the tibiæ, and first joints of tarsi yellowish-red. Wings nearly hyaline, slightly clouded in the outer cells, stigma brownish, last section of fourth vein straight, rectangular, joining the third nearly at right angles opposite the tip of second vein, clouded with brown, the cloud either extending across to tip of second vein or more or less interrupted in front of the third. Long. corp. 6–7 mm., Washington Territory, California.

Differs from *C. nitidus* Wied., which it closely resembles, in its larger size, the second joint of antennæ proportionately a little shorter, and the concavity of lower part of face being less, in the absence of abdominal fasciæ, and in the termination of the fourth vein.

CHRYSOGASTER NIGROVITTATUS Lw., Zeit. f. Ges. Naturw. 1876, p. 323. Colo., Washington Terr. ! Calif.

DD.—Face and front without transverse wrinkles; false vein always present, the fourth vein never bent inwards toward the tip; face usually with distinct tubercle, third joint of antennæ never elongate. Small or medium sized species, more or less pilose, abdomen never slender. **Cheilosia.**

This genus, a very large one in Europe, has hitherto consisted of but seven described species, none of them from west of the Rocky Mountains. I describe here five additional ones from the Western regions, two of them belonging to the division with pilose eyes hitherto undescribed in this country.

Three or four of Dr. Loew's species are unknown to me, but this writer's familiarity with the genus enables his species to be placed with a good deal of certainty from the descriptions alone. In the identification of species described in but one sex, it should be remembered that in the female the pilosity of the eyes is less, the antennæ usually lighter colored, and the third joint larger.

a.—Eyes distinctly pilose.....*b*.
—Eyes bare.....*c*.
b.—Third joint of antennæ (♂) small, oval, blackish; face with sparse long pile; wings not lighter toward the base....*occidentalis*, sp. nov.
—Third joint of antennæ (♀) larger, subquadrate, reddish; wings lighter toward the base.....*lasiophthalmus*, sp. nov.
c.—Scutellum with bristly hairs on its border.....*d*.
—Scutellum without bristly hairs on its border.....*h*.
d.—Humeri, scutellum, and lower part of the face, luteous; face strongly excavated above; arista pubescent.....*e*.
—Black shining; arista pilose (except in *tristis*).....*f*.
e.—All the femora except the apex black.....**leucoparea*
—Hind femora, except base and apex, black.....**pallipes*.
f.—Legs black, knees, base and apex of tibiæ and more or less of the tarsi, luteous.....*g*.
—Anterior legs luteous, posterior blackish with the base and apex of femora and tibiæ and last joints of tarsi luteous.....*plumata*.
g.—Second and third segments of abdomen, except anterior angles, opaque (♂).....*tristis*.
—Second and third segments of abdomen wholly shining (♂).....*cyanescens*.
h.—Abdomen with distinct, entire cross-bands, legs, except the posterior femora, red.....*rufipes*, sp. nov.
—Abdomen without metallic bands.....*i*.
i.—Second and third segments of abdomen opaque (♂).....*j*.
—Abdomen wholly shining.....*k*.
j.—Legs black.....*nigripennis*, sp. nov.
—Legs luteous, femora black.....**capillata*.
k.—Legs black.....*comosa*.
—Legs in large part luteous.....*parva*, sp. nov.

CHEILOSIA TRISTIS Lw., Cent. iv, 71. British America. Three male specimens from Oregon and Washington Territory agree so closely with the description of this species, that I believe it to be the same. I have no other specimens with which to compare them.

CHEILOSIA COMOSA Lw., Cent. iv, 66. Colorado! Red River of the North. The previous remarks will apply equally well to this species.

CHEILOSIA OCCIDENTALIS, sp. nov.

♂.—Frontal triangle black, with black pile, swollen with a depression; antennæ black, third joint somewhat brownish, nearly orbicular, small, arista with scarcely perceptible pubescence. Face shining black with sparse lutescent pile, scarcely concave from base of antennæ to tip of tubercle, deeply and shortly concave below the latter. Eyes thickly pilose, lutescent below, fuscous above. Thorax deep green black, with brown or blackish pile, intermingled with shorter lutescent. Abdomen oval, not at all slender, deep, somewhat metallic green, shining, pile lutes-

cent, longer than in the thorax, especially on the sides of the anterior segments, the dorsum in the middle nearly bare. Legs black with black and lutescent pile, tibiæ reddish at base and extreme tips. Tegulæ light yellow, halteres yellow. Wings smoky brown, darker in front and at the root. One specimen. California. Long. corp. 11 mm.

An additional species from California has larger, more reddish subquadrate third joint of antennæ, arista short pilose, no pile that I can distinguish in the face, and the pile of the body shorter.

CHEILOSIA LASIOPHTHALMUS, sp. nov.

♂.—Frontal triangle moderately swollen, with an impressed longitudinal line, and light yellowish pile. Antennæ brownish red, third joint rather large, nearly square, arista bare, black. Face deep black, shining with yellowish pubescence, slightly excavated below the antennæ, considerably produced below the eyes, a well-marked groove begins at the base of the antennæ, runs obliquely outward to the eye, and then curves downward near the eye into the cheek. Posterior orbits below broadly dusted with yellow. Eyes thickly reddish-yellow pilose. Thorax metallic green, shining, thickly covered with light yellow pile, on the pleuræ bushy. Abdomen broad oval, shining black, with abundant pile like that of the thorax. Tegulæ light yellow. Legs black with yellow pile, femora at the tips, base and tips of tibiæ, and basal joints of intermediate tarsi, yellow or luteous. Wings subhyaline, with an indistinct brownish spot near the middle, basal part yellowish. Long. corp. 10–11mm. Four specimens. Colorado.

Female specimens that may belong to this species from California have the pile much shorter and more grayish. They are too badly preserved, however, for me to determine with any degree of assurance.

CHEILOSIA RUFIPES, sp. nov.

♀.—Front and face shining black, the former on the sides and the latter except the tubercle lightly covered with minute gray pubescence. Antennæ blackish, third joint twice as long as wide, reddish on the under side, arista bare. Thorax metallic green, lightly punctulate, pile very short, whitish; scutellum with an indistinct, transverse groove. Abdomen black, with a metallic reflection, smooth, shining, elongate oval, with a small tuft of whitish pile on the side of the second segment, and very short, elsewhere; second segment with large oval spots in front, narrowly separated; third segment with broad cross-bands in front, attenuated in the middle; the fourth segment with similar but less attenuated; the fifth segment partly or wholly, bluish green. Legs red, posterior femora annulate near the middle, or almost wholly brown or blackish, terminal joints of tarsi infuscated. Wings hyaline, stigma dilutely yellow. Long. corp. 8–9 mm. Washington Territory, California. Five specimens.

The abdomen is not sufficiently fasciated to place it among the *Melanostomæ*; in everything else it presents the characters of *Cheilosia*.

CHEILOSIA NIGRIPENNIS, sp. nov.

♂.—Deep black, eyes bare. Frontal triangle and face shining black, the former fossulate, the latter very slightly excavated below the antennæ. Antennæ small, basal joints black, third joint reddish-brown or brown, rounded. Thorax black, nearly opaque, with short black pile above and longer on the pleuræ and scutellum, the latter shining. Abdomen short, broadly oval, depressed, opaque black with a bluish cast, pile on the sides of the anterior segments, reddish-yellow, anterior angles of third and fourth segments, shining metallic. Tegulæ with blackish border, and a fringe of black pile. Legs black. Wings blackish in front, clearer behind, veins black. Long. corp. 7–8 mm. Three specimens from Mt. Hood, Oregon.

CHEILOSIA PARVA, sp. nov.

♀—Shining greenish-black, with a brassy reflection. Eyes bare. Front and face shining, the former with short, fuscous pile, the latter moderately excavated below the antennæ, tubercle broad, obtuse. Antennæ black, third joint oval, somewhat reddish below. Thorax and abdomen with short, lutescent pile, sparse on the latter, which is elongate oval. Legs luteous; the anterior femora toward the base, rings of the tibiæ, and terminal joints of tarsi and the posterior legs except the ends of femora, base and tips of tibiæ, brown or blackish. Wings lutescent, veins black. Long. corp. 5–6 mm. Mt. Hood, Oregon.

IV.

A.—Small cross-vein before the middle of the discal cell.
2.—Antennæ shorter than the head.
aa.—Face tuberculate or hyperstoma produced.
*.—Abdomen linear or oval, never club-shaped.
††—Black with luteous, reddish or yellow; if uniformly black, the hind femora thickened.

E.—Hyperstoma produced into a long, slender porrected snout; femora slender (the third longitudinal vein joins the costa beyond the tip). **Rhingia.**

The single American species of this genus *R. nasica* Say, is very common in the Eastern States, but I have never seen a *Rhingia* from beyond the Mississippi.

EE.—Face not produced into a snout like hyperstoma, femora more or less thickened.
F.—Face not produced, extending but little beyond the eyes, in ♂ much more tuberculate than in ♀; hind femora usually with spines below, abdomen oval. Mostly black species or with luteous markings at base of abdomen, scutellum, humeri, cheeks, etc..... **Myiolepta.**

Four species have been described from Eastern North America, and the genus is now recorded for the first time from the West.

PROC. AMER. PHILOS. SOC. XX. 112. 2M. PRINTED AUGUST 3, 1882.

MYIOLEPTA VARIPES Lw., Cent. ix, 79. Virginia.

Specimens very closely allied to this species, if not the same, I have from Washington Territory and Kern county, California. The lateral margins of the second segment and basal parts of all the tarsi are luteous. In the male the facial tubercle is prominent, though small.

MYIOLEPTA BELLA, sp. nov.

♀.—Black, shining. Front with very short black pile above; face bare, much produced, in profile briefly convex in the middle of the concavity between antennæ and tip. Antennal basal joints nearly black, third joint large, orbicular, red, arista black. Thorax with short, black pile, somewhat intermixed with yellowish, longer on the border of the scutellum. Abdomen very shining with short, whitish pile, longer and bushy on the sides of the second segment. Halteres light yellow. Legs black with black pile. Wings smoky or brownish toward the end. Stigma brown. Long. corp. 7-8 mm. Three specimens, Washington Territory; Mt. Hood, Oregon.

FF.—Face more or less produced, extending considerably below the eyes. Either wholly or in large part luteous or reddish, the arista frequently pubescent or pilose.

G.—Face carinate, abdomen oval.....**Brachyopa.**

Our species may be tabulated as follows:

a.—Arista distinctly pubescent; face and antennæ yellow or yellowish-red .....*b.*

—Arista bare.....*c.*

b.—Dorsum of abdomen brown.....**ferruginea.*

—Dorsum of abdomen yellowish-red, with brown incisures, and a brownish median line.....*notata.*

c.—Face and front brownish, densely clothed with grayish pollen, abdomen mostly brown.....*vacua.*

—Face yellow, upper part of front (♀) brownish-black, antennæ yellow, third joint large; abdomen reddish-yellow with brownish incisures.....*media*, sp. nov.

BRACHYOPA? NOTATA O. S., Cat. Dipt. 247. White Mts., N. H. (O. Sacken); Mt. Hood, Oregon; Washington Territory!

BRACHYOPA VACUA O. S. Canada (O. S.); Kern Co. California!

A single female specimen from this locality agrees so closely with Baron Osten Sacken's description that I believe it to be the same species. The legs and antennæ are, however, more reddish than brownish, and the wings are quite hyaline, more so than the preceding.

BRACHYOPA MEDIA, sp. nov.

♀.—Face and lower part of front reddish-yellow, the latter projecting rather more than *notata;* antennæ the same color or a little lighter, the third joint very large, arista brown, yellowish at the base, front in the upper two-thirds black, grayish pollinose. Dorsum of thorax nearly

black, with short white pile and thick gray pollen, leaving three darker stripes, scutellum red; abdomen yellow, the segments with narrow posterior brownish lines. Legs reddish-yellow, the hind tibiæ somewhat brownish, terminal joints of tarsi fuscous, or black, hind femora a little incrassate. Wings hyaline with a slightly yellowish tinge; first posterior cell briefly petiolate, the base of second posterior cell is an obtuse angle, about midway between the two preceding species. Long. corp. 6–7 mm. One specimen, Kern county, California.

GG.—Face more produced, obtusely tuberculate; abdomen long (xylotiform); with scutellar, postalar, dorsopleural and mesopleural bristles. All the femora thickened and irregularly spinose..... **Eugeniamyia** Wlstn.

EUGENIAMYIA RUFA Wlstn., Canada Entomologist, Vol. xiv, p. 80, California!

V.

A.—Small cross-vein, before the middle of the discal cell.
2.—Antennæ shorter than the head.
a.—Marginal cell open.
aa—Face tuberculate.
*.—Abdomen elongate, not club-shaped.
†††.—Black or greenish-black, with yellow or yellowish or ferruginous interrupted abdominal cross-bands.
§.—Face black.

H.—"Wings not longer than the abdomen; ocellar tubercle large, prominent; abdomen depressed, long, elliptical, somewhat narrowed at the base, the lighter markings ferruginous or orange-yellow" (Schiner).....***Pyrophæna.**

HH.—Wings longer than the abdomen; ocellar tubercle not unusually large, abdomen more slender, the cross-bands yellow, or greenish-yellow.

I. Anterior tibiæ and metatarsi of male dilated.....**Platycheirus.**

PLATYCHEIRUS QUADRATUS Say. Washington Territory, Kern Co., California!

I cannot distinguish specimens from these localities from our Eastern ones; the color of the hind legs vary much as they do in the East.

? PLATYCHEIRUS HYPERBOREUS Staeger.

Another species from Washington Territory does not differ in any noteworthy degree from a female specimen of *hyperboreus* identified by Baron Osten Sacken, but the male's tibiæ are not dilated. I am strongly inclined to believe that the dilatation is nothing more than a specific character, and that the name *Platycheirus* should be given up as misleading, and all the species placed under *Melanostoma*. *P. quadratus*, is variable, and only a large amount of material will settle the question whether they are a group of closely allied species, or merely varieties; in the former case, the genus should be retained, in the latter, it should be united with *Melanostoma*.

II.—Anterior tibiæ and tarsi of male not dilated.....Melanostoma.

MELANOSTOMA TIGRINA O. S., West Dipt. 323, Washington Territory, California! common.

MELANOSTOMA SCALARIS Meigen; Schiner, Fauna Austr. Dipt., 291, Colorado! Europe and North America.

VI.

J.—Small cross-vein before the middle of the discal cell.
2.—Antennæ short.
a.—Marginal cell open.
aa.—Face tuberculate, hyperstoma not produced.
*.—Abdomen oval or elongate, not club-shaped.
†††.—Black or greenish-black, with yellow markings.
§§.—Face wholly or in part yellow.
π.—Dorsum of thorax with yellow lateral stripes.

J.—Abdomen with seven visible segments, the hypopygium unusually large.....Sphærophoria.

I have numerous specimens of this genus from the Western regions, among which there are probably four or five species. I recognize, however, only one species, viz:

SPHÆROPHORIA MICRURA O. S., West Dipt., 330, California!

* SPHÆROPHORIA SULPHURIPES Thomson, Eugen. Resa, 501 (*Syrphus*), O. S., l. c., Calif.

JJ.—Abdomen not showing more than six segments, hypopygium not unusually large.

K.—Eyes of male with an area of enlarged facets above; abdomen rather slender, fourth segment with yellow median stripes and oblique side spots.....Allograpta.

* ALLOGRAPTA FRACTA O. S., West Dipt., p. 331. Santa Monica, Cal.

KK.—Eyes of male without area of enlarged facets (fourth segment of abdomen fasciate).

L.—Thorax with a median, dorsal, cinereous line; ocellar tubercle remote from vertex; slender species.

M.—Posterior femora enlarged and bent.....Toxomerus.

TOXOMERUS GEMINATUS (Say). Washington Territory! California, Eastern States.

Scæva geminata Say, Compl., Wr. ii, 80.

Toxomerus notatus Macq., Dipt. Exot., 5 Suppl., 93.

Mesograpta geminata Schiner, Novara Exped. O. S. Cat. Dipt. p. 125, West. Dipt., p. 330.

MM.—Postorior femora simple.....Mesograpta.

MESOGRAPTA MARGINATA (Say), O. S., Kern Co. Cal.! Atlantic States, common.

LL.—Thorax without median dorsal cinereous stripe, ocellar tubercle as usual; abdomen more oval.

N.—Head obtusely conical, front plane, face receding, third joint of antennæ orbicular.....**Doros.**

NN.—Front more rounded, face less receding, third joint of antennæ large, elliptical.....**Xanthogramma.**

a.—Bands of abdomen entire or sub-interrupted.....*felix.*

b.—Bands of abdomen broadly interrupted:

XANTHOGRAMMA DIVISA, sp. nov.

♂♀.—Face and cheeks yellow, or reddish-yellow. Front metallic greenish-black, continued as a broad stripe to the base of the antennæ, somewhat expanded below, on the sides yellowish. Antennæ black, somewhat reddish below on the sides of the second and third joint near the base, third joint oval obtuse as in *felix*, but a little smaller. Dorsum of thorax deep metallic green with yellow lateral stripes, pleuræ yellowish with white pile. Scutellum a somewhat translucent yellow, its base narrowly black. Abdomen: first segment with a small yellow spot on each side just under the halteres, second segment with an oval spot on each side, somewhat attenuated toward the middle, third and fourth with large rectangular spots, separated by nearly their own width; fifth with an anterior fascia narrower in the middle and encroaching slightly upon the preceding segment. Legs yellow, anterior and middle femora sometimes narrowly brown annulate near the base, posterior legs mostly brownish or blackish, except the base of femora and knees. Wings hyaline, with a smoky tinge, stigma yellowish. Long. corp. 9–11mm. Eight specimens. Washington Territory.

VII.

Δ.—Small cross-vein before the middle of the discal cell.

2.—Antennæ short.

a.—Marginal cell open.

aa.—Face tuberculate, hyperstoma not produced.

*.—Abdomen oval.

†††.—Black, or greenish-black, with yellow markings.

§§.—Face wholly, or in part, yellow.

ππ.—Dorsum of thorax uniform, without lateral stripes.

O.—Thickly pilose species; abdomen quite oval, broader beyond the middle; face perpendicular, somewhat projecting below and reaching far back under the eyes. (Basal portion of abdomen yellow, terminal portion black, wings with dark spot. *L. lucorum*).....**Leucozona.**

LEUCOZONA LUCORUM (Linné), Schiner—Meig. Beschr. iii, 313; Tab. 30, f. 27 (*Syrphus*); Mt. Hood, Oregon! Europe; North America.

OO.—Rather bare species; abdomen with yellow bands, either all entire, or one or all interrupted.

P.—Eyes of male with an area of enlarged facets above; front very convex; hypopygium very small.....**Catabomba.**

CATABOMBA PYRASTRI (Linné), O. S. Meig., System Beschr. iii (*Syr-*

phus.) Europe and Western America. Very abundant in the Pacific regions.

PP.—Eyes of male without area of enlarged facets above; front moderately convex; hypopygium not very small.

Q.—Sixth abdominal segment of male as long as two preceding together, but narrower, somewhat tubular, unsymmetrical; on underside of seventh segment two long linear sub-parallel appendages, arcuate, bidenticulate at end, embedded in grooves when at rest. In the female fifth segment half as long as preceding. Scutellum much raised, exposing metanotum.....**Eupeodes.**

EUPEODES VOLUCRIS O. S., West Dipt., 329. Washington Territory, Kern county, California. ! Nevada, Utah, Colorado, common.

QQ.—Hypopygium without slender appendages, sixth segment of male not peculiar; fifth segment of female one-third or one-fourth as long as preceding.

R.—Third longitudinal vein with a distinct sinuosity; third joint of antennæ elongate-oval.....**Didea.**

Table of Species:

a.—Third joint of antennæ obtusely pointed; third longitudinal vein, with a considerable sinuosity. Abdominal cross-band of second and third abdominal segments broader towards, but not quite reaching, the lateral margin.....*fuscipes.*

aa.—Third joint of antennæ more evenly oval; the third longitudinal vein less sinuous;

b.—Abdominal cross-bands attenuated at outer ends, and usually quite meeting the lateral margins:

DIDEA LAXA O. S., Cat. Dipt. 245. White Mts.; Mt. Hood, Oregon; Washington Terr. !

bb.—Abdominal cross-bands nearly obsolete:

? DIDEA ALCIDICE.

Syrphus Alcidice Walker, List, etc., iii p. 579. Hudson Bay Terr.; Osten Sacken Cat. Dipt., 2d Ed., p. 244, note 205.

A single specimen from Mt. Hood, Oregon, resembles *D. laxa* very much, but the two small oval yellow spots of the second segment, the remaining segments being dark metallic green with an opaque, black longitudinal line, seem to indicate a distinct species, and apparently Walker's *Alcidice*. The generic differences of both these species, however, from some species of *Syrphi* (*e.g.*, *S. lapponicus*), are feeble.

RR.—Third longitudinal vein straight or gently curved; third joint of antennæ short oval.....**Syrphus.**

This genus appears to be a prominent one in the Western regions; many of the Eastern species appear, and others have strong resemblances. Two species which present well marked characters, I describe as new. The following table contains, with the exception of *dimidiatus*, *tarsatus*, and *fumipennis*, all of the known species north of Mexico. It is composed

of the two tables given by Osten Sacken (Proc. Bost. Soc. N. H., 1875, p. 138, and West. Dipt., p. 325), united, with the addition of the species herein described.

SYRPHUS.

a.—Second and third cross-bands of abdomen never interrupted.....*b.*
—Three principal cross-bands broadly interrupted.....*i.*
b.—First cross-band broadly and distinctly interrupted in both sexes....*c.*
—First cross-band narrowly interrupted in the male; not interrupted in the female.....*h.*
c.—Abdomen elongated, narrrow, linear.....*diversipes.*
—Abdomen oval.....*d.*
d.—Femora black at the base.....*e.*
—Femora yellow at the base.....*ribesii* ♀, *protritus.*
e.—Abdominal cross-bands do not reach the lateral margins.....*g.*
—Abdominal cross-bands reach quite the lateral margins.....*f.*
f.—Eyes pubescent.....*torvus.*
—Eyes glabrous.....*ribesii* ♂.
g.—Cross-bands attenuated on the sides.....*opinator.*
—Cross-bands reach the sides in nearly their full width; not attenuated near the ends.....*Lesueurii.*
h.—Face yellow.....*abbreviatus.*
—Face with brown stripe.....*americanus.*
i.—Abdomen elongated, narrow, linear.....*j.*
—Abdomen oval.....*l.*
j.—Eyes pubescent.....*velutinus*, sp. nov.
Eyes glabrous.....*k.*
k.—Antennæ inserted on yellow ground.....*umbellatarum.*
—Antennæ inserted on black ground.....*geniculatus.*
l.—Eyes pubescent.....*m.*
—Eyes glabrous.....*o.*
m.—Abdominal spots straight.....*n.*
—Abdominal spots coarctate in the middle, sometimes broken in two; face conspicuously brown or black in the middle.....{ *amalopis.* / *intrudens.*
n.—Face yellow; third longitudinal vein straight.....*contumax.*
—Facial stripe and front black.....*velutinus*, sp. nov.
o.—Abdominal spots lunate, face with black on the tubercle..*lapponicus.*
—Abdominal spots straight, face without black....*disjunctus*, sp. nov.

SYRPHUS LAPPONICUS Zett., Dipt., Scand. ii, 701, 3. Wyoming Terr., Kansas, Oregon, Southern California, New England! Greenland, Europe. Specimens taken in Connecticut, late in October, have the sinuosity of the third vein as strongly marked as in any Western ones. The species is widespread and common.

SYRPHUS OPINATOR O. S., West. Dipt., 327, Oregon, Washington Terr.,

California! Apparently a common species, as twenty-five specimens are in my collection.

SYRPHUS RIBESII Linné, O. S., Pr. Bos. Soc. Nat. Hist., 1874, 139. Oregon, California, New England! Europe. Male specimens with the basal portion of the femora black, agree quite with Eastern specimens.

*SYRPHUS PROTRITUS O. S., West. Dipt., 328 Marion Co., California. Unknown to me.

SYRPHUS LESUEURII Macq., O. S., Pr. Bos. Soc. Nat. Hist., 1875, 143. Washington Terr.! A single specimen agrees closely with those from New England.

*SYRPHUS INTRUDENS O. S., West. Dipt., 326. California. Unknown to me.

SYRPHUS AMERICANUS Weid., O. S., Pr. Bos. Soc. Nat. Hist. 1875, p. 145. Female specimens agree quite with New England ones, and I have little doubt of their identity. Calif., Oregon!

*SYRPHUS FUMIPENNIS Thomson, Eugenies Resa, 490, California.

SYRPHUS VELUTINUS, sp. nov.

♂♀.—Eyes distinctly pubescent. Face obscurely yellow, with a broad median black stripe, extending to the oral margin; antennæ deep black. Frontal triangle brassy black, extending to the base of the antennæ. Front (♀) black, brassy in the middle. Thorax greenish-black, with a metallic lustre, and rather abundant rufous pile, pleuræ white pollinose, the pile more whitish. Scutellum black in the basal part, subtranslucent yellowish at the margin. Abdomen long (shaped nearly like *Platycheirus*) nearly parallel on the sides towards the end of the fourth segment; the color opaque black with short black pile and three interrupted cross-bands; the first pair of spots in the second segment, broad, nearly square, separated by less than half their width, whitish-yellow, second and third pairs narrow, rectangular, separated by about their own width, not attenuated before the lateral margins, bluish-white. Legs black, terminal half of anterior and middle femora, anterior and middle tibiæ, except brownish rings beyond the middle, yellow. Wings hyaline, stigma brown. Long. corp. 11–12 mm. Two specimens. Mt. Hood, Oregon.

SYRPHUS DISJUNCTUS, sp. nov.

♂.—Eyes bare. Frontal triangle blackish, with a brassy reflection; face reddish-yellow with a bluish reflection, without any stripe or spot on the tubercle, cheeks black, the oral border behind, yellow. Antennæ brownish-black, the basal half of third joint yellowish-red. Thorax metallic green black, with short reddish pile, longer on the scutellum; scutellum bluish opalescent, black at the base. Abdomen black, with three pairs of bright yellow spots, the first pair small oval, second and third pairs nearly square, rather broader on the outer sides, separated by a very distinct black space from the lateral margins, fifth segments on the anterior corners, yellow. Legs sordid yellow, anterior and middle femora toward the base, and posterior legs except more or less of the tip of femora

and base of tibiæ brown or brownish-black. Wings tinged with brownish, the stigma darker, third longitudinal vein very slightly curved. Long. corp. 9–10 mm. Four specimens. Washington Ter.

VIII.

J.—Small cross-vein before the middle of the discal cell.
2.—Antennæ short.
a.—Marginal cell open.
aa.—Face tuberculate or hyperstoma produced.
**.—Abdomen contracted toward the base, more or less club-shaped.

S.—Posterior femora slender; wings usually with brown; face tuberculate; hyperstoma retreating; longer, more slender species..... **Bacha** (*Ocyptamus*).

The differences between these two genera I cannot satisfactorily make out. I have two species of *Bacha* from California, both of which seem different from:

*Bacha lemur O. S., West Dipt., 331. Cal., New Mexico and:

*Bacha angusta O. S., West Dipt., 332, California.

SS.—Posterior femora swollen; hyperstoma produced; short, small species.
T.—Hyperstoma produced anteriorly, in profile deeply concave from antennæ to tip; third joint of antennæ nearly orbicular; the fourth longitudinal vein joins the third in a right or acute angle.. **Sphegina.**

Three species from Washington Territory and Oregon correspond pretty well with S. lobata Lw., S. infuscata Lw. and S. rufiventris Lw., but in the absence of better material in this genus, I will not venture to describe them.

TT.—Hyperstoma produced more downward, in profile very slightly concave from antennæ to tip, the fourth longitudinal vein joins the third in nearly a right or obtuse angle..... **Ascia.**

Ascia metallica, sp. nov.

♂♀.—Front and face metallic bronze black, shining, the latter white pollinose. Antennæ black, third joint brownish-black below, near the base red. Thorax metallic-green black, finely punctured. Abdomen like the thorax, the third segment, in the female, with two, small or indistinct, spots near the front; in the male the front half except the angles red. Legs with the anterior and middle femora, except the base and ends, the posterior coxæ, femora, except the basal fourth, tibiæ, except the basal third and tips, and the posterior metatarsi black, other parts light yellow. Wings hyaline. Long. corp. 4–5 mm.

Three specimens, Mt. Hood, Oregon.

PROC. AMER. PHILOS. SOC. XX. 112. 2N. PRINTED AUGUST 8, 1882.

The black of the legs, in one specimen, includes a larger part, with a portion of the anterior and middle tarsi.

IX.

A.—Small cross-vein before the middle of discal cell.
2.—Antennæ shorter than the head.
aa.—Marginal cell closed and petiolate.

U.—Second and third joints of antennæ elongate; arista very densely plumose, appearing like a solid mass.....***Copestylum.**

* COPESTYLUM MARGINATUM (Say), O. S. Say, Compl. Wr. ii, 360 (*Volucella*). Mexico, Texas.

UU.—Third joint of antennæ elongate; arista feathery plumose..... **{ Volucella, Temnocera.**

* VOLUCELLA AVIDA O. S., West Dipt., 333. California. Mexico.

VOLUCELLA SATUR O. S., l. c., Colorado. Utah!

VOLUCELLA FASCIATA Macq., Dipt. Exd., ii. 2, 21, 1. Western Kansas! Texas, Colorado. Mexico.

VOLUCELLA FACIALIS, sp. nov.

♂♀. Closely related to *V. evecta* Walk., but differs in the face being quite yellow, with yellow pile, and the dorsum of thorax and pleuræ being covered with black pile.

Face yellow, yellow pilose, cheeks black, shining, bare. Antennæ: first two joints brownish-black, third joint red, or reddish-brown, arista darker, black plumose. Front in female yellow, darker at the vertex, yellow pilose; frontal triangle (♂) black, or brown with shorter yellow pile, vertex with tuft of long yellow pile. Thorax black, shining, the dorsum broadly black pilose, in front and behind and on the sides with longer yellow pile, pleuræ with black pile. Abdomen black, shining, second segment except the middle third or half, and narrow posterior border, light yellow, the narrow posterior part of third, the fourth and fifth segments conspicuously red pilose, other parts of abdomen with shorter black pile. Legs black, black pilose, basal portion of tibiæ and all the tarsi dark red. Wings hyaline, the veins with brown clouds, a brown spot opposite the small cross-vein. Long. corp. 14–15 mm. Three specimens. California.

The posterior part of the abdomen in *V. evecta* is usually black pilose without any trace of the red, but rarely in some specimens the abdomen is marked precisely like *facialis*, and hence it is quite probable that specimens of the California species may sometimes lack the rufous pile. The black pile of the thorax will at once distinguish the species or variety if it should prove to be such, as in a large number of specimens of *evecta* I have never found any with such thoracic pile. However, as regards its specific distinction, see *Eristalis flavipes melanastomus* Lw.

The genus *Temnocera* is an unsatisfactory one, and I believe ought to be suppressed. The characters relied upon are the more slender third joint of antennæ, and the presence of bristles on the scutellum.

I do not know either of the following species :

*Temnocera setigera O. S., West Dipt., 334, New Mexico.
*Temnocera megacephala Lw., Centur. 15, 57. California.

X.

JJ.—The small cross-vein at or beyond the middle of the discal cell, oblique.

α.—Antennæ with a distinctly dorsal bristle.

β.—Third longitudinal vein deeply sinuous.

γ.—Marginal cell closed and petiolate.

V.—Thorax never with yellow spots ; wings hyaline or with a dark spot ; face obtusely tuberculate.....**Eristalis.**

Eighteen species of Eristalis are recognized by Baron Osten Sacken as having been described from America, north of Mexico. More than twice as many names have been given, chiefly by Walker and Macquart, but the facilities enjoyed by Osten Sacken, together with his well-known accuracy and faithfulness, render it unnecessary to any further discuss the most of them at present.

Since the publication of this catalogue two species have been published by Bigot in the *Annales des Soc. Ent. de France*, 1880, 216–217. *E. parens* is given below in part ; *E. zonatus* = *E. transversus* Wied.

I have endeavored to tabulate below all of the species known to me, and have added the diagnoses, or descriptions, of all the remaining, with the addition of what I identify as *E. Meigenii* Wied., a South American species = *E. androclus* O. S. (non Walker, undescribed, see catalogue, etc.), together with two new ones. The genus though large, and especially predominating in America, is readily defined, showing comparatively little structural variation. The eyes are contiguous, or sub-contiguous, usually pilose, although in some species, as *tenax*, occupying only a spot in the middle ; in *æneus* they are nearly bare, being sparsely pilose near the top. The third joint of the antennæ is sub-quadrate, thus at once distinguishing it from *Volucella* and *Temnocera*. The face is never produced, in nearly all of the species with a not very prominent tubercle, with a median stripe and cheeks black, bare, and shining. From *Milesia* and *Pteroptila* it may readily be distinguished by the absence of distinct yellow spots or stripes on the dorsum of the thorax, which is, however, sometimes distinctly fasciate or vittate with dull gray or olivaceous ; from the latter genus also by the absence of pubescence on the wing, though, indeed, this character is only relative. There is a tendency to differences of coloration and markings between the male and female, sometimes so striking as to cause one to doubt their relationship. Such differences may consist in the absence of yellow upon the abdomen, or in the presence of stripes of the

thorax. The wings show scarcely any variation ; the third longitudinal is deeply bent into the first posterior cell, and the marginal cell is closed, the latter character separating it from all other North American genera except the ones previously mentioned.

ERISTALIS.

1.—Arista naked or indistinctly pubescent.....2.
—Arista pilose or distinctly pubescent (near the base).....3.

2.—Scutellum of the same color as thorax, abdomen without light markings, shining, eyes nearly bare, spotted in life, dorsum of thorax in female distinctly vittate.....*æneus.*
—Scutellum yellowish translucent, lighter than the thorax ; abdomen unicolorous, shining blackish, with indistinct or subobsolete side spots on second segment, pile of eye mostly confined to an elongated vertical elliptical line. Size and appearance of a honey-bee....*tenax.*

3.—Thorax with thick or long pile, posterior border of third segment not velvety black, wings mostly with a brown spot.....4.
—Thorax and abdomen nearly bare, or with short, not wooly pile, the abdominal segments usually with lighter hind borders. Less *Bombus*-like.....8.

4.—Tarsi red, large species ; humble bee-like.....5.
—Tarsi dark, smaller species.....6.

5.—Thorax wholly yellow pilose above.....*flavipes.*
—Thorax with black pile in the middle when seen from the side.....
flavipes var. *melanostomus.*

6.—Abdomen with yellow or reddish on the sides of the second segment only, thickly mostly black pilose elsewhere, posterior half of third, and the fourth segment shining ; legs black.....*Bastardi.*
—Third segment with yellow or red, the pile of the abdomen almost wholly yellowish, and long.....7.

7.—Abdomen mostly reddish-yellow with a nearly equal median black stripe ; eyes barely meeting in the male ; legs black.*montanus*, sp. nov.
—Third segment with a smaller reddish-yellow spot in the side, second segment velvety black, third with a triangular velvety expansion in front.....*occidentalis*, sp. nov.

8.—Third abdominal segment with a posterior velvety black cross-band *not interrupted* in the middle.....9.
—Third abdominal segment with a distinctly interrupted band, or else wholly shining. Not with a complete band.....13.

9.—Thorax with transverse olivaceous fasciæ, front narrow above (♀).10.
—Thorax without such fasciæ.....11

10.—Hind femora not swollen, second segment of abdomen with large spots, third segment in the male, with anterior rectangular spots wanting in the female, and hind borders of second, third and fourth segments yellow. Legs varying from almost wholly yellow with black on tips of hind femora and tibiæ, to black with yellow knees...
transversus.

—Hind femora distinctly swollen, bands of thorax conspicuous, third segment of abdomen in female often with red or yellow side spots, otherwise resembling the previous species very much, and like it quite variable ..... *vinetorum.*

11.—Third segment of abdomen broadly and conspicuously yellow, joining the yellow of the second segment in front, the velvety fascia of third segment abbreviated on the sides; thorax with indistinct stripes; eyes of male touching each other very slightly..... *?Meigenii* Wied.

—Third segment of abdomen without yellow, eyes of male broadly contiguous..... 12

12.—Front of female narrow. Deep bluish-black, scutellum scarcely different, the abdomen with dull or obsolete triangular spots, the hind borders of the segments indistinct or absent, conical; tips of femora, the posterior at the base especially in the female, basal half of tibiæ, and more or less of basal joints of anterior and middle tarsi, light yellow. Wings with a dark spot..... *saxorum.*

—Front of female broad. Lighter markings of abdomen (the lateral triangles and posterior borders) usually quite distinct, sometimes nearly obsolete; third and fourth segments with a velvety median triangular expansion with its base in front; tips of femora, anterior and middle tibiæ, except tips and basal half of posterior tibiæ yellow. Wings sometimes with a distinct brown spot..... *hirtus.*

13.—Third segment without (or with very minute) velvety markings, abdomen mostly shining, second, third, and fourth segments with fringe of white pile..... 14.

—Third segment of abdomen with an anterior spot, and a posterior interrupted velvety black fascia, second segment with sub-obsolete triangular yellow spots, posterior border of segments narrow or indistinct; basal half of all the tibiæ yellowish-white. Wings pure hyaline..... *dimidiatus.*

14.—Second segment of abdomen with yellow triangles, and a posterior uninterrupted or subinterrupted velvety cross-band, posterior margin of segments 2–4 yellowish-white, with a fringe of pale golden yellow hairs. (Length 9–13 mm.)..... *stipator.*

—Second segment except the metallic side spots that extend the whole length of the segment, velvety black; third segment with a velvety triangle in front, the fourth with similar, but very small; the yellowish-white hind borders fringed less conspicuously with light colored pile..... *Brousii*, sp. nov.

Eristalis inornatus Lw., Centur. vi, 68. Red River.

Diagnosis, translation. ♀. "Sub-brassy black, shining, clothed with rather long lutescent pile ('pube'); front broad, near the eyes black pilose, but the vertex itself with luteous pile; eyes pilose; antennæ reddish ferruginous, the first two joints black, the arista pilose; face, except the usual stripes yellow, with dilutely lutescent pile and pollen; scutel-

lum wholly testaceous; each segment of the abdomen except the first with a black posterior fascia, second and third emarginate and velutinous, the following sub-shining and in the posterior margin, very narrowly yellow. Feet black, extreme apex of the femora, the basal half of anterior and posterior tibiæ, the middle tibiæ except the apical third and the first joint of the middle tarsi, pallid yellowish; 'alæ hyalinæ, vena disci colore subfusco late circumfusis.'" Long. corp. $6\frac{1}{4}$ lin., Long. al. $4\frac{3}{8}$ lin.

Eristalis obscurus Lw., l. c. 67. Red River.

Diagnosis, translation. "♀. Brassy black shining, clothed with rather long dilutely lutescent cinerous pile; front broad, above black pilose; eyes pilose, antennæ reddish ferruginous, first two joints black, arista pilose, face except the usual stripes yellow testaceous, white pollinose and white-pilose; scutellum brown, black near the base; each abdominal segment except the first with a posterior black fascia, not emarginate and with a very slender posterior yellow margin; feet black, apex and base of all the femora, the basal third of anterior and posterior tibiæ, intermediate tibiæ except the apex, and the first two joints of all the tarsi pallid yellowish; wings pure hyaline, veins of the disc clouded with fuscous. Long. corp. 5–$5\frac{1}{2}$ lin., long. al., $4\frac{1}{3}$–$4\frac{2}{3}$ lin.

Eristalis latifrons Lw., l. c. 65. Matamoras, Texas, Iowa.

Diagnosis, translation. "♂♀. Black, moderately shining, wholly pallidly pilose; antennæ fuscous, setæ bare, luteous; scutellum testaceous; second segment of the abdomen with two sub-triangular testaceous spots, posterior margin pallid, posterior margins of the following segments pallid, in front pallidly pollinose; feet black, the knees, tibiæ, except the apex, and the base of the intermediate tarsi, pallid flavescent; eyes of the male contiguous, in the female by the front broadly separated. Long. corp. $5\frac{1}{4}$–$5\frac{1}{3}$ lin., long. al. $4\frac{1}{6}$–$4\frac{1}{2}$ lin.

Eristalis atriceps Lw., l. c. 64. White Mts., Canada.

Diagnosis, translation. "♂. Black, shining; head wholly concolorous, antennæ obscurely rufous, arista bare; scutellum and two spots of the second abdominal segment brown; posterior margin of the second, third, and fourth abdominal segments pallid yellow; wings hyaline, costa except the apical third fuscous-clouded. Long. corp. $4\frac{1}{3}$–$4\frac{5}{12}$ lin., long al. $3\frac{2}{3}$ lin."

Eristalis pilosus Lw., l. c. 70. Greenland.

Diagnosis, translation. "♂♀. Black, thickly clothed with long yellow pile; eyes black pilose; antennæ black, arista bare; face black; thorax unicolorous, opaque; scutellum luteous; first two abdominal segments opaque, secured on each side with a dilutely lutescent spot; third segment black, with two opaque spots, confluent in an abbreviated fascia; two ultimate segments brassy [metallic], black, shining, with a minute triangular spot, opaque; pile of the dorsum lupinous, on the sides of the middle

black, remainder yellow; wings pure hyaline, veins fuscous black, in the female with blackish spots.—Long. corp. 5½–6½ lin., long. al. 4½–5½ lin."

Eristalis æstriformis Walker, List, etc., iii, 573 (*Syrphus*). Hudson's Bay Territory.

"Mas. Niger, thoracis pilis anticis nigris pootecis fulvis, scutello fulvo, abdomine pilis albis nigris fulvisque fasciato, antennis piceis, pedibus nigris, alis limpidis fusco unimaculatis.

"Body black; head clothed with dull tawny hairs, shining and prominent in front; mouth pitchy; feelers pitchy; bristle ferruginous, downy; eyes pitchy, each with a broad stripe of short black hairs; all the facets very small; chest clothed with short black hairs, and on the hinder part with pale tawny hairs; scutcheon tawny, very thickly clothed with pale tawny hairs; abdomen nearly oval, broader and a little longer than the chest, clothed with white hairs at the base, with black hairs in the middle, and with bright tawny hairs towards the tip; legs black, clothed with short black hair; knees pitchy; shanks and feet clothed beneath with tawny down; hind feet tawny; claws and foot cushions tawny; tips of claws black; wings colorless; large dark brown spot in the disk; wing ribs pitchy; veins black, ferruginous towards the base and along the free borders; poisers ferruginous. Length of the body 7 lines; of the wings [spread] 14 lines."

Eristalis albiceps Macq., Dipt. Exot. ii, 2, 56, 41, Carolina.

"Ater. Thorace antice duabus fasciis transversus albidis. Abdominis primo, secundo tertioque segmentis maculis lateralibus flavis. Facie frontique albis. Long. 4 l. ♂."

"Face testacie, a duvet blanc et bande nue, luisante. Partie antérieure du front a duvet et poils blancs. Antennes testacées. Yeux nus. Thorax d'un noir velonté; la seconde bande transversale sur la suture; ecusson fauve. Abdomen, les taches latérales laissant un espace etroit entrélles; celles du troisième segment n'atteignant pas le sord posterieur; incisions jaunes; quatrième à petits poils noire. Cuisses noires, à genoux fauves; jambes jaunes, à extremité braune; tarses noirs. Balanciers jaunes. Ailes hyalines; à base un peu jaunatre; cellule basilaire externe s'étendant jusqu'à la moitié de la discoidale."

Eristalis parens Bigot, Dipt. Nouv. xxi, Annal Ent. Soc. Fr., 1878, 216. Diagnosis, translation. ♂. Eyes pilose, arista at the base briefly pilose (similar to *E. arbustorum*); antennæ reddish-brown; face black, on the sides obscurely cinereous pilose; thorax black, densely fulvous pilose; scutellum fulvous; tegulæ testaceous; abdomen, second segment, on each side, with a broad spot, triangular, fulvous, third with similar, but narrower, spots, narrowly margined with yellow; femora obscurely reddish-brown, knees and tibiæ pallid testaceous; apex broadly reddish-brown, tarsi obscurely red, apex slightly infuscate; wings nearly hyaline, base and external border, dilutely and very pallidly infuscated. Long. 13mm. North America.

ERISTALIS TENAX (Linné). Meig. Atlantic and Middle States, Washington Territory! Europe, Asia, Africa. A single specimen from the Pacific coast agrees in every respect with Eastern ones. The distribution of this species is remarkable; although at present very abundant in the region of New England, it was never observed or known to collectors longer ago than 1874!

ERISTALIS FLAVIPES, var MELANOSTOMUS Lw., Centur. vi., 69. I have a single female specimen from Oregon that I doubtfully refer to this species. While the dorsum of the thorax is black pilose the yellowish pile of the abdomen is confined to the terminal segments. I have collected large numbers of *flavipes* in Connecticut, and among them I have found *typical* specimens of *melanostomi* and others agreeing quite with the specimen from Oregon, while still others have the yellowish pile of the abdomen more or less intermixed with black. A typical *melanostomus* presents a very different appearance from *flavipes*, and yet from the collection I have, I doubt the specific distinction. The name *melanostomus* may be retained, however, to express the difference, more particularly of the dorsal thoracic pile.

ERISTALIS STIPATOR O. S., West. Dipt., 336. Colorado, Western Kansas! New Mexico, California.

ERISTALIS HIRTUS Lw., Cent. vi, 66; O. S. West. Dipt., 335. Wash. Terr., Oregon, California, Colorado! A very common species, over thirty specimens are in my collection. They show a considerable variation as observed by Osten Sacken (l. c.).

ERISTALIS (?) MEIGENII Wied., Aus. Zwei. Ins. ii, 177, 35, pl. x., fig. 15. (*E. androclus* O. S.), Brazil (Wied.) New England! Utah, Alaska (see O. Sacken. West. Dipt, 337). This species agrees so closely with Wiedman's figure and description of *Meigenii* from Brazil, that I believe it to be the same. I shall, however, send specimens for comparison with South American ones.

ERISTALIS MONTANUS, sp. nov.

♂.—Eyes thickly pilose, sub-contiguous; front and face reddish-black with yellow pile, the facial stripe and cheeks black, shining; antennæ brownish-black, arista bare. Thorax black, densely covered with yellow pile, the scutellum yellow. Abdomen reddish-yellow, with thick reddish-yellow pile, first segment black; second segment in the middle opaque black, narrowed behind, in the third segment the black is confined to a broad median stripe, opaque in front, shining behind; fourth segment similar, wholly shining, hypopygium black. Legs black with black pile, all the tibiæ at the base yellowish-red. Wings hyaline with a brown spot. Long. corp. 12 mm. One specimen. Wyoming Territory.

ERISTALIS OCCIDENTALIS, sp. nov.

♂♀.—Eyes pilose, front (♀) brownish-black, dusted with yellow on the sides, face on the sides thickly covered with same colored dust, and

whitish-yellow pile, median stripe and cheeks shining black; antennæ reddish-brown, arista red pubescent. Thorax black, with rather short, thick, yellow pile; scutellum sub-translucent yellow with longer pile. Abdomen black, thickly covered with yellow pile more or less intermixed with black at the incisures, second segment on the sides broadly yellow, in the middle wholly opaque; third segment on the sides with smaller reddish spots, extending one-half or two-thirds of the way back, and a broad, shining cross-band narrowly interrupted in the middle; fourth segment shining, with a small opaque spot in front. Legs black with black pile, knees and basal third of all the tibiæ yellow. Wings hyaline with a small dark brown spot. Long. corp. 10–12 mm. Four specimens. Washington Territory.

Eristalis Brousii, sp. nov.

♀.—Eyes with short whitish pile; front brownish-black in the middle, thickly covered with red dust on the sides, pile below yellowish, black near the ocelli, face with whitish pile and yellowish-white dust, narrowly shining black in the middle, cheeks black, shining; antennæ brownish-black, arista brownish-yellow, sparsely pilose. Thorax on the dorsum brownish-olivaceous, somewhat brassy on the sides; in the middle forming two rather broad stripes, inclosing a narrow black stripe that is broadest beyond the suture; pleuræ black with longer whitish pile, the pile of the dorsum rather short reddish-yellow; scutellum reddish-brown. Abdomen black, sub-metallic shining, with very short whitish pile, posterior margins of second, third and fourth segments broadly whitish-yellow, the velvety black occupies the whole of the middle of the second segment, expanding narrowly outward in front of the whitish posterior margin; third segment has the velvety black confined to a triangle on the anterior part, extending narrowly backward; fourth segment with a small spot in front. Legs black with white pile, tips of femora and basal third of all the tibiæ yellow. Wings hyaline with an indistinct brownish spot. Long. corp. 10–12 mm. Three specimens. Massachusetts, July 3.

For some time I was inclined to consider this the female of what I identify as *E. Meigenii* Wied.

VV.—Wings covered with minute pile, brown on anterior portion; thorax often with yellow spots.....**Pteroptila.**

PTEROPTILA CRUCIGERA (Wied.), Aus. Zwei. ii, 105, 2. Georgia! Florida, Texas, Central America.

XI.

ΔΔ.—Small cross-vein at or beyond the middle of discal cell.

α.—Arista dorsal.

β.—Third longitudinal vein deeply sinuous.

γγ.—Marginal cell open; posterior femora swollen.

PROC. AMER. PHILOS. SOC. XX. 112. 2o. PRINTED AUGUST 8, 1882.

W.—Face carinate.....see XIII.
WW.—Face tuberculate, or rounded, not carinate.
X.—Face of male less tuberculate than in female, body uniformly black, without markings.
Y.—Hind tibiæ of male with a strong projecting spine in middle. **Teuchocnemis.**
YY.—Hind tibiæ of male without such spine.....***Pterallastes.**
XX.—Face alike in both sexes, abdomen in male at least (except *Mallota*) not uniform.
Z.—Hind coxæ with spur, duller in the female, hind femora with triangular protuberance, hind tibiæ with terminal spur (♂ abdomen mostly red, ♀ nearly black).....**Polydonta.**

POLYDONTA CURVIPES (Wied.), Aus. Zwei. ii, 149, 3. O. S. West. Dipt., 338. New England! California. The probability is that the species somewhat doubtfully referred to this by Osten Sacken, l. c., is the same.

ZZ.—Hind legs without such spurs or protuberances.
a.—Third joint of antennæ broad, face concave below the antennæ (thorax not vittate, thickly pilose) abdomen without bands.....**Mallota.**

MALLOTA SACKENI, sp. nov.

Mallota posticata O. Sacken, West. Dipt., 338.

♂. Differs from *M.* (?) *posticata* of the Eastern States in a dark brown spot on the wing, in the marginal cell being closed in the border, and in the eyes of the male not being contiguous, otherwise quite like the Eastern species.

Frontal triangle and face gray with yellow pile, broad facial stripe and cheeks deep black, shining; antennæ black, third joint more or less brownish. Dorsum of thorax and pleuræ with long dense yellow pile, scutellum yellow, similarly pilose, abdomen deep shining black, nearly bare, legs deep black, with black pile, middle and posterior tarsi brownish-red, posterior femora very much thickened. Wings hyaline with a large brown spot, reaching from the origin of the third vein to the small cross-vein, the second longitudinal enters the costa at tip of the first, not at some distance beyond, as in the specimens I have of the Eastern species. Long. corp. 14mm. Washington Territory. Two specimens.

aa.—Third joint of antennæ ovate, face excavated or not below the antennæ, thorax, or at least abdomen, with markings....**Helophilus.**

HELOPHILUS LATIFRONS Lw., Cent. iv, 73. Wyo.! Northern States, Nebraska, California.

HELOPHILUS MEXICANUS Macq. (*H. polygrammus* Lw. Cent. x. 55. See also O. Sacken, Catalogue, Errata.) Apparently a very common species. I have seventeen specimens from Washington Territory and California.

HELOPHILUS, sp. A small species from Wyoming, apparently undescribed.

XII.

ΔΔ.—Small cross-vein at or beyond the middle of discal cell.
a.—Arista dorsal.
ββ.—Third longitudinal vein gently curved.
δ.—Arista feathery plumose.
ε.—Marginal cell open.

b.—Thickly pilose; abdomen without bands, short, thick, arched; hind femora strongly thickened, tibiæ much bent; face straight, extending back under the eyes, conical, pointed; wings with a brown spot.....***Arctophila.**

*ARCTOPHILA FLAGRANS O. S., West. Dipt., 335. Colorado Mountains.

bb.—Less pilose; abdomen with bands; hind femora slender; face truncate.....**Sericomyia.**

SERICOMYIA CHALCOPYGA Lw., Cent. iii, 20. Washington Territory, Mt. Hood, Oregon! Sitka. A dozen specimen from the two former localities, I have no doubt belong here; the male not described by Loew, differs in having the third segment wholly opaque.

XIII.

ΔΔ.—Small cross-vein at or beyond the middle of discal cell.
a.—Arista dorsal.
ββ.—Third longitudinal vein gently curved.
εε.—Arista bare or pubescent.

c.—Marginal cell closed; thorax with yellow markings; abdomen fasciate; antennæ short.....**Milesia.**
cc.—Marginal cell open.
d.—Long, slender, abdomen narrower toward the base (wings more or less brownish).....**Ocyptamus** (Bacha).
dd.—Abdomen never linear or club-shaped.
e.—Face distinctly carinate, convex or nearly perpendicular in profile, hyperstoma not produced, eyes bare, hind femora incrassate, with a triangular protuberance.....**Tropidia.**

TROPIDIA QUADRATA (Say). Compl. Wr. 1, 14 (*Xylota*). Washington Terr., California, New England!

ee.—Face without a distinct median ridge or carina, or if somewhat carinated, the hyperstoma produced.
f.—"All the femora strongly thickened and spinose below; tarsi crassate. Face tuberculate; antennæ short, third joint as long as two preceding. Small cross-vein subnormal; first posterior cell acute at outer anterior angle, rounded on outer posterior part, the section of vein at distal end of cell, sinuate. Body proportionately short and broad, bare, with minute squamæ." Loew, Century v, 38. Small species.....***Lepidomyia.**
ff.—All the femora not strongly thickened and spinose below. Mostly large species.
g.—Nearly bare species, especially on the abdomen, the pile never long nor dense; eyes bare.

h.—Face descending but very little below the eyes, arched or subcarinate, never tuberculate.

i.—Third segment of abdomen in male very much contracted, cylindrical, the hind femora much swollen, with bifid spine below at the tip. Eyes very large, face small.....**Senogaster** Macq., Hist. Nat. Dipt. 2.

Senogaster Comstocki, sp. nov.

♂.—Head globular, large, composed almost wholly of the eyes which meet in front for a short distance above the antennæ, the vertical triangle narrow, long; a small but very distinct area of enlarged facets on each side above the antennæ. Frontal triangle and face small, the latter arched, subcarinate, short, concave from antennæ to tip, yellow with silvery glisten, and a brownish median stripe. Cheeks narrow, antennæ reddish-yellow, first joint very short, second nearly equilaterally triangular, third joint oval, arista bare. Thorax black, with four narrow, but conspicuous olivaceous stripes, the outer pair extending from the more reddish, somewhat swollen humeri. Pleuræ black, with a conspicuous broad white-dusted vertical patch; scutellum black, yellow at the tip; abdomen brownish-black; first segment as broad as thorax, nearly black, yellow on the sides; second segment elongate, scarcely half as wide behind, with two silvery elongate spots; third segment of the same length, narrow, cylindrical, yellow in front; fourth segment as long as preceding, with the globular hypopygium forming a spheroidal mass. Legs yellow, hind femora much swollen, arcuated, black, becoming red at the tip, below at the end with slender process, and beyond a smaller tooth-like one, hind tibiæ arcuated with a triangular projection at the end, hind tarsi brownish, wings nearly hyaline, third longitudinal vein gently curved. Long. corp. 12 mm., long. al. 8 mm., N. Y., Cornell University. Prof. J. H. Comstock.

The present species is a very interesting addition to our fauna. Hitherto, so far as I can learn, but one species is known, *S. cærulescens* Mac., l. c. and Dipt. Exot. 11, 2, 72, Tab. 13, f. 3, from Guiana, South America. I take much pleasure in dedicating it to Prof. Comstock, whose work in Entomology is so favorably known.

ii.—Hind femora more or less swollen with spines or bristles below, abdomen elongated, somewhat flattened, not contracted in the middle. Thorax without distinct yellow markings.

j.—Hind femora very much swollen; small cross-vein at right angles to longitudinal veins.....**Syritta.**

Syritta pipiens Linné. Meigen Zweifl. Ins. iii, 213. Europe. Common apparently over all of North America.

jj.—Hind femora never remarkably swollen, hind coxæ often with a spinous process, small cross-vein of wing always oblique...**Xylota.**

Xylota obscura Lw., Cent. vi, 55. Mt. Hood, Oregon; Wash. Terr. Calif. ! Red River of the North. Specimens from the former localities

agree so closely with Loew's description that I believe them to be the same.

XYLOTA EJUNCIDA Say. Compl. Wr. 1, 15; Pl. 8, fig. 4. Wash. Terr., Calif. ! New England. Numerous specimens from these localities resemble so closely the Eastern ones, that I scarcely doubt their identity. The third joint of the tarsi varies from yellowish to quite black, and the spine or tubercle of the hind coxæ is quite distinct; the antennæ vary somewhat is color. Is *X. quadrimaculata* Lw. really a distinct species? Observe the discrepancy between the diagnosis and description as regards the male coxæ.

XYLOTA PIGRA (Fab.) Meigen. Oregon, Wash. Terr., Calif. ! Europe and North America. Common.

XYLOTA, sp. nov. Colorado.

Differs from *S. bicolor* Lw. in the presence of long coxal spines; in all the tarsi except the last two joints, the anterior and middle tibiæ, and the posterior tibiæ at base and tips being yellowish-red.

hh.—Face descending more or less below the eyes, often obtusely tuberculate. Thorax either with distinct spots or abdomen banded.

k.—The sixth vein beyond the junction of the posterior basal cross-vein, extends forwards subparallel to the border, the discal cell rounded on its posterior angle, hind femora swollen (and with a triangular protuberance below on outer part; anterior part of wings more or less clouded).

l.—Second joint of antennæ, elongate; antennæ about as long as head.....**Mixtemyia.**

ll.—Second joint of antennæ not elongated, the antennæ shorter than head.....**Spilomyia.**

SPILOMYIA INTERRUPTA, sp. nov.

♂♀.—Very closely allied to *S. longicornis*, but seems to show a constant difference in that the first, third and fifth cross-bands are distinctly though narrowly interrupted, and that the last section of the sixth longitudinal vein is distinctly shorter, scarcely more than half as long as the posterior basal cross-vein. The posterior side of the hind femora are in some specimens quite black. Washington Territory.

The generic differences between our species of Mixtemyia and Spilomyia are very trivial.

kk.—The last section of the sixth vein short, running directly into the border of the wing, hind femora not swollen, nor with spines or projection below.

m.—Antennæ inserted high up on a conical projection, front very short, face much produced directly downwards, obtusely tuberculate, antennæ shorter or longer than the head.....**Sphecomyia.**

SPHECOMYIA VITTATA (Wied.) O. S., Wied. Aus. Zwei., ii, 87, and 91 (*Psarus ornatus*). Eastern States ! Colorado.

*SPHECOMYIA BREVICORNIS O. S., West. Dipt., 341. California.

SPHECOMYIA PATTONII, sp. nov.

♂ ♀. Antennæ reddish-black, very short, joints nearly of the same length; the first cylindrical, the second sub-triangular, the third rounded, reddish below; arista reddish. Face golden yellow, with a black stripe reaching from the antennæ to the oral margin, cheeks black; front in female black with a golden spot on each side. Thorax black, a large spot on the pleuræ and a smaller one under it, humeri and basal part of scutellum yellow. Abdomen black; first segment with a narrow posterior border, second segment with two narrow yellow cross-bands; the anterior one near the middle of the segment broadly interrupted, the posterior marginal one entire; third and fourth segments similar, the middle cross-bands successively a little wider and less broadly interrupted; fifth segment nearly all yellow. Femora brownish-black at the base, becoming reddish at the end, especially on the posterior pair. Anterior tibiæ, except the base and tarsi, quite black, middle and posterior tibiæ and tarsi, except the last two joints, reddish-yellow. Wings tinged with brownish along the veins, hyaline in the middle of the cells. Long. corp. 13–14 mm. Two specimens. Washington Territory.

This species is very like *Sphecomyia brevicornis* O. S., but differs in the antennæ being still shorter, and the picture of the abdomen different.

mm.—Antennæ short, situated low down, near the middle of head in profile, the projection less prominent; face not much produced, not longer than the front..... .....**Temnostoma.**

gg.—Larger pilose species, the abdomen always with short, furry pile; dorsum of thorax never with yellow markings other than on the humeri.

n.—Scutellum, margin and pleura of thorax with bristly hairs; face distinctly tuberculate; femora slender; abdomen uniform metallic, not banded.....**Chrysochlamys.**

The following table of the North American species I reproduce from Osten Sacken (West. Dipt., 340), without change:

Arista black.....*crœsus.*

Arista reddish.

Leg entirely reddish-yellow.....*dives.*

Anterior femora at base and tips of all the tarsi black....*buccata.*

All the femora brown; tibiæ likewise infuscated.....*nigripes.*

CHRYSOCHLAMYS CROESUS O. Sacken. West. Dipt., 341. Washington Terr., California! Utah.

nn.—Thorax without any bristly hairs.

o.—Face short, not produced, extending but very little below the eyes, shorter than the front, concave from antennæ to tip, not tuberculate, transversely arched, hind femora more or less thickened.

p.—Abdomen elongate, hind femora with short spinous bristles below.....**Brachypalpus.**

BRACHYPALPUS PULCHER Wlstn. Can. Entomologist, vol. xiv, p. 78. Oregon, Washington Terr. Readily recognized by the abdominal segments being broadly banded and bordered behind by brilliant brassy or bronze, the fourth segment in the male wholly so. The first segment in the male with a narrow posterior border extending across from its side spots.

pp.—Abdomen very broad, thorax densely pilose, very large species..... **Hadromyia** Wlstn, l. c.

HADROMYIA GRANDIS Wlstn., l. c. Washington Terr. The present species is the largest Syrphid of which I have any knowledge; it measures nearly an inch in length by a third of an inch in width across the abdomen.

oo.—Face produced, longer than the front.

q.—Face produced forwards, pointed, concave from antennæ to tip, not tuberculate, subcarinate, eyes of male contiguous or nearly so in front of ocellar tubercle, hind femora thickened, usually with bristly points below, abdomen without yellow markings. **Crioprora.**

A.—Dorsum of thorax beset with thick or yellowish or yellowish-rufous pile, on the pleura black; wings with brownish clouds along the veins.

a.—Front in female broad, beset with yellow pile.....**alopex* O.S.

b.—Front in female narrow, beset with black pile..*femorata*, sp. nov.

B.—Dorsum of thorax beset with long grayish or whitish pile, above on pleuræ yellowish-white, abdomen dark bluish-metallic (in the male with black opaque second segment, and a black opaque cross-band on third)..... { *cyanella* O. S. / **cyanogaster* Lw.

I have never seen a specimen of *cyanogaster;* it is probably distinct from *cyanella*, although the description applies quite well to my female *cyanella*. A comparison is needed of specimens from the Atlantic and Pacific States in order to make the description of Loew's species more complete.

*CRIOPRORA ALOPEX O. S., West Dipt., 338 (*Pocota*). California.

CRIOPRORA CYANELLA O. S., l. c., 339. California. Osten Sacken's description, as usual, is quite accurate.

CRIOPRORA FEMORATA, sp. nov.

♂♀. Everywhere deep shining black. Front in female narrower than in *cyanella*, with black pile, eyes in male less contiguous than in *cyanella;* the face a little less produced and more obtusely pointed. Antennæ reddish-brown, arista yellow. Thorax and scutellum with rather abundant yellow pile, black on the pleuræ. Abdomen with a brassy reflection, black pilose, intermingled with longer yellow on the sides of the second segment. Legs wholly black pilose, the anterior tibiæ and tarsi with golden pubescence. Hind femora in the male much thickened in the male and bent with a row of short spinous tubercles below, posterior coxæ obtusely

tuberculate, and tibiæ in lower third strongly bent; in female the femora and tibiæ not bent, the former swollen but the tubercles indistinct. Wings with brown clouds along the vein and a very dark spot near the tip of auxiliary, the inner portion of the cells hyaline. Long. corp. 15–16 mm. Washington Territory.

pp.—Face, not evenly concave, tuberculate; hind femora slender.
g.—Face produced downwards and forwards, proboscis long; eyes of male well separated, abdomen uniformly black, short, broad..... **Eurhinamallota** Big.

Bul. Soc. Ent. Fr. Apr. 1882, No. 6, p. 78, *Brachymyia* Williston, Can. Entomologist, Vol. xiv, p. 76, May, 1882.

EURHINAMALLOTA LUPINA, Wlstn., l. c. California.

EURHINAMALLOTA NIGRIPES Wlstn., l. c. Northern and Southern California. I know this species only in the female; should the male's eyes be found to be contiguous in front of the ocellar tubercle, I know of no other character to separate it from *Eriophora*, Phillipi Ver. Zool. Bot. Gesells. Wien., 15, 735, 1865, pl. 26, fig. 36.

qq.—Face produced directly downward, more or less arched or tuberculate in the lower part.
r.—Eyes of male separated by the ocellar tubercle. Antennal prominence very conical, abdomen with 3–4 pairs of large oval, oblique yellow side spots..... **Somula decora.**
rr.—Eyes of male more or less contiguous in front of the ocelli; antennal prominence conical..... **Criorrhina.**

Table of species.

a.—Abdomen wholly black.....**armilata.*
b.—Three basal segments and base of fourth black, remainder yellow.... *analis.*
c.—Second segment with triangular lateral spots; in female the anterior margins of third and fourth in the sides with yellow spots; humeri yellow.....*humeralis*, sp. nov.
d.—Second segment with an interrupted cross-band, third and fourth with entire cross-band, attenuated in the middle behind and on the sides.. *scitula*, sp. nov.

CRIORRHINA HUMERALIS, sp. nov.

♂ ♀.—Face yellow, shining with a semi-translucency; cheeks black; front in female on upper half, black; whitish pollinose on the sides below the vertex, frontal triangle in male like the face; antennæ yellow, somewhat infuscated on the first two joints and on upper part of third; thorax black, with short thin yellow pile; scutellum black, the edge luteous; abdomen black, with recumbent, not abundant yellow pile; second segment with triangular yellow spots, in the female the third and fourth, with rectangular yellow spots on the anterior margins, fifth mostly yellow except a narrow median line and the tip; legs yellow, front and middle, and a ring on distal part of posterior femora, posterior tibiæ in middle,

posterior metatarsi, and three last joints of all the tarsi brown; wings hyaline. Long. corp. 10–11 mm. Two specimens. Washington Territory.

I suspect that the male may also show in some degree the abdominal markings other than the spots on second segment, and that the coloration of the legs may be variable.

CRIORRHINA SCITULA, sp. nov.

♂♀. Face yellow, in profile with a well marked obtuse tubercle; cheeks black; front in female black on upper three-fourths, with grayish-red club and short black pile; frontal triangle in male yellow; eyes contiguous for a longer distance than in *analis*, the antennal protuberance not so great. Antennæ yellowish-brown or blackish-brown, the second joint sometimes yellow with black above, third joint always of a lighter color below; thorax black, shining, dorsum with blackish pile, yellowish on the borders; humeri yellow with smaller confluent yellow pleural spots; mesopleuræ gray pilose and pollinose; scutellum black, the edge sometimes narrowly luteous; abdomen black; second segment with two large yellow spots rather narrowly separated, with rounded heads and narrowed toward the margins; third segment with a yellow cross-band on the anterior margin, doubly convex behind, the greatest convexity being toward the middle, with sharp median angular incision, and attenuated nearly to a point on the sides of the abdomen; fourth segment similar in female, in male wholly black or with triangular spots on anterior margin and reddish behind; hypopygium red or yellow. Anterior coxæ white pollinose in front, femora black except the extreme tips, anterior and middle tibiæ and metatarsi, yellow or reddish-yellow; posterior tibiæ yellow at the base and tip; terminal joints of anterior and middle tarsi black; posterior tarsi fuscous or black; wings nearly hyaline, rather more clouded toward the front. Long. corp. 11–13 mm. Eight specimens. Washington Territory, Oregon.

This species has the face in profile similar to that of *Milesia notata* Wied. ("Genus novum" O. S. Catalog. p. 138) as figured by Macquart.

XIV.

AA.—Small cross-vein beyond the middle of discal cell, oblique.
aa.—Antennæ with a subterminal bristle or terminal style.

s.—Third joint of antennæ produced above into a long conical process, inclined forward and terminating in the thickened arista; abdomen oval black, with three interrupted metallic cross-bands; third longitudinal-vein straight.....**Merapioidus** Bigot.
Merapioidus villosus Bigot., Bul. Soc. Ent. Fr. 1879, p. 64. Georgia!

ss.—Antennæ longer than the head, second and third joints swollen, terminating in a short thickened style; third longitudinal vein strongly angulated, emitting a stump of a vein into the first posterior cell.....**Ceria.**

PROC. AMER. PHILOS. SOC. XX. 112. 2P. PRINTED AUGUST 14, 1882.

Table of species:

a.—Antennal projection of the front very short; first joint of antennæ nearly as long as last two together.....* *signifera.*
—Antennal projection nearly as long as first joint of antennæ, the latter scarcely longer than the second joint.

b.—Second, third and fourth segments of abdomen each with two yellow spots and posterior margin.....* *pictula.*
—Abdomen without such spots, banded.

c.—Second segment of abdomen much shorter than the third; front of female black with yellow spots.....♀..*abbreviata.*
—Second segment of abdomen nearly as long as third; front of female yellow below, black above.....*tridens.*

CERIA TRIDENS Lw., Cent. x, 57. Loew's description applies very well to a single male specimen from Southern California, except that the cheeks are wholly black, and the hind tarsi yellow at the base. Other specimens from Washington Territory, however, that are apparently of the same species, have the anterior and middle femora black, except the extreme tips, the posterior black, except at the base, the tibiæ fuscous near the outer ends, one of the pleural spots and the supra-alar vittula entirely wanting. The female differs in the front being black on the upper two-thirds; the second and third segments of the abdomen strongly marked with whitish pollen, and the legs almost wholly yellow, the anterior femora being blackish in front, the posterior lightly fuscous near the tip. A female *abbreviata* taken with a male at New Haven, has its legs yellow also with fuscous markings of the femora; the front is black with four small yellow spots.

Stated Meeting, June 16, 1882.

Present, 4 members.

President, Mr. FRALEY, in the Chair.

A letter accepting membership was received from C. E. Rawlins, dated Rockmount, Ramhill, England, May 12, 1882.

Mr. P. H. Law accepted his appointment to prepare an obituary notice of the late Mr. Vaux, by letter dated May 23, 1882.

A request for exchanges (to be dated back at least to 1875) was received from the Société Zoologique de France, No. 7 Rue des Grands Augustins, Paris, in a letter dated May 27, and signed H. Pierson, Sec. Adjt. On motion the Librarian was

directed to send full sets of Proceedings and Transactions to the Society.

A request for exchanges was received from the Leander McCormick Observatory of the University of Virginia. Action postponed.

A letter of envoy was received from Dr. B. A. Gould, Cordova.

Letters of acknowledgment were received from the Public Library of N. Bedford (110); the R. Institution, London (109), and the Wyoming Historical and Geological Society (75, 77, 88, 99).

Donations for the Library were received from the Mining Surveyors at Melbourne; Prague Observatory; Dr. A. Tischner, Leipsig; Dr. G. D. E. Weyer in Kiel; Turin Academy; Academia dei Lincei; Geographical Societies in Paris and Bordeaux; London Astronomical Society; London Nature; British Topographical Society; Mr. Chas. Edward Rawlins, Jr.; R. Geological Society of Cornwall; Boston Natural History Society; Middlesex Institute; American Journal of Science; American Museum of Nat. History; Chas. W. Shields, D.D.; Buffalo Young Men's Association; New Jersey Historical Society; Philadelphia Academy Natural Sciences; Zoölogical Society; Engineers' Club; Journal of Pharmacy; Mr. H. C. Lewis; American Pharm. Association; Penna. Magazine; American Chemical Journal; American Journal of Mathematics; Peabody Institute; U. S. National Museum; Fish Commission; G. M. Wheeler (U. S. Geographical Surveys); University of Virginia; Missouri Historical Society; Ministerio de Fomento; Revista Mexicana; Observatory at Cordova (B. A. Gould); American Philosophical Association.

The death of W. B. Rogers, at Boston, May 30, aged 77, was reported by the Secretary; and Dr. R. E. Rogers was appointed to prepare an obituary notice of the deceased.

The following communications were made:

"Revision of the Dermestidæ of the United States," by Horace F. Jayne, M.D., with 4 plates.

"Radiant Heat an Exception to the Second Law of Thermodynamics;" by H. T. Eddy, Ph.D., University of Cincinnati.

Pending nominations Nos. 959, 960, 961, and new nominations Nos. 962, 963 were read.

C. G. Ames was appointed by the President in the place of the late S. W. Roberts as a member of the Committee on the Hall.

And the meeting was adjourned.

Radiant Heat an Exception to the Second Law of Thermodynamics.
By H. T. Eddy, Ph.D., University of Cincinnati.

(*Read before the American Philosophical Society, June 16, 1882.*)

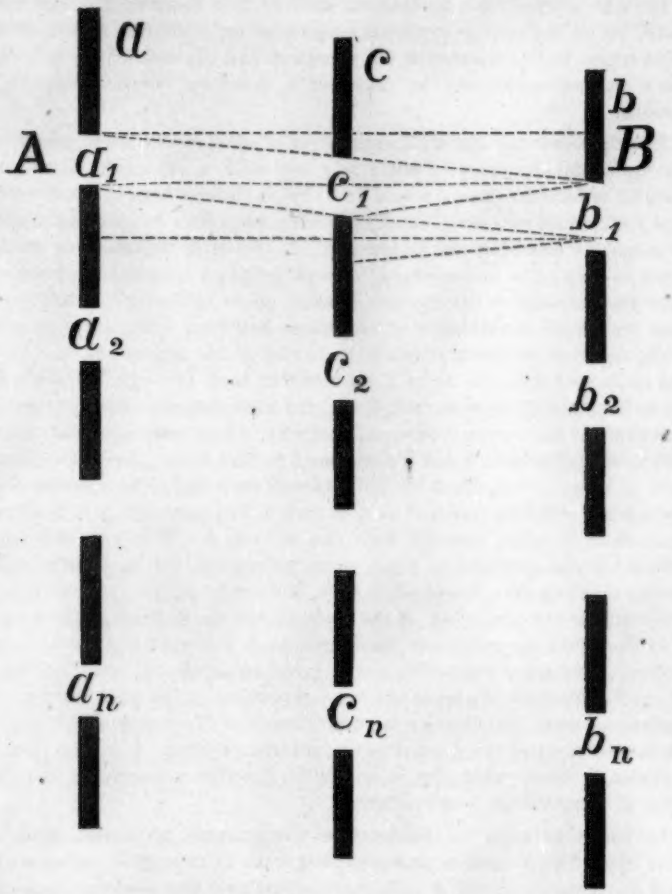
Since the radiation of heat takes places by propagation through space at a certain finite velocity and not instantaneously, it is quite possible for occurrences to intervene during the exchange of radiations between two bodies such as to essentially change the distribution of heat which would otherwise have ultimately taken place.

To make this evident, let us employ first a mechanical analogy. In the accompanying figure, let there be three parallel screens, a, b and c, the latter between the two former and all three perpendicular to the plane of the paper. Let them be pierced respectively by series of equidistant apertures $a_1\ a_2\ \ldots\ a_n$, $b_1\ b_2\ \ldots\ b_n$, $c_1\ c_2\ \ldots\ c_n$, situated in the plane of the paper, and let these apertures be so placed that $a_1\ b_1\ c_1$ are upon one straight line, not quite at right angles to the screens; then are $a_2\ b_2\ c_2$, etc., and $a_n\ b_n\ c_n$ upon lines parallel to $a_1\ b_1\ c_1$. Now conceive the screens $a\ b\ c$ to have a common uniform velocity u in the direction from the c_2 to c_1.

Also let a series of projectiles be discharged from any fixed position A at the left of the screen a at such instants as to pass the first one through the aperture a_1, the second through a_2, etc., and let the direction of discharge be perpendicular to the screens, and the velocity v such that each one shall just reach the screen b in time to pass through the first aperture of that screen which crosses its path. Then would the screens $a\ b\ c$ in no way interfere with the passage of these projectiles. Let us denote the space at the left of a as the space A, and that at the right of b as the space B. Then if there be a continuous discharge of projectiles from all points of the space B, only a part of them can pass through the apertures of a. Such however as succeed in passing a will pass b and c also.

Again, let a second discharge of projectiles take place from the space B but directed toward the left perpendicularly to the screens, so that these projectiles move in a precisely opposite direction from those first mention-

ed. Let the projectiles from B have the common velocity v'. Such of these projectiles as succeed in passing through the apertures of b will impinge on c at points between its apertures, in case c be placed at a proper distance from b. Let the surface of c which faces b be perfectly reflecting, and let the parts between its apertures be either concave or a series of inclined



planes so directed that each of the projectiles on rebounding will pass back through one of the apertures in b. When the velocity v' of the projectiles is large compared with that of the screens u, the projectiles can be made to return through b very nearly perpendicularly, either by returning each projectile through that aperture from which it started or through some following one.

The paths of the projectiles relative to the screens can be readily found by impressing upon the projectiles, in addition to their velocities v or v', a velocity $-u$, numerically equal and opposed to that of the screens, while the screens themselves are at rest. The composition of these velocities will give the required relative velocity.

In order to apply the mechanical analogy just considered to the case in hand, let us replace the supposed projectiles by radiations which emanate from warm bodies situated in the spaces A and B, and let the only radiations at first considered be those in a direction perpendicular to the screens.

It is then evident that with such series of apertures as are represented in the figure the screens a b c could be given such a velocity u, as accompanied by reflections from c would transfer radiations from the body A to B unaccompanied by a compensating transfer from B to A, and thus the body B would be heated at the expense of A. Even if radiations at the apertures in a and b be not confined to rays perpendicular to the screens, but take place instead in the manner usual at plane surfaces, it is still evident that the usual interchange of radiations has been effectively interfered with, and that the body B would be heated at the expense of A. In case the radiations from the body B are reflected back through the same apertures from which they started, it is quite unnecessary to have the series of apertures in the screen a at equal distances. It is only necessary that the series of apertures in b and c correspond to that in a. Indeed each aperture in b can be conceived to be completely surrounded by a concave semicylindrical reflector attached to c, of such a form as to return to b all radiations from it when moving with the velocity u. This can certainly be effected if the apertures in b are mere points and can be closely approximated to when they are small. Now, if there be in this cylinder a proper aperture for the admission of the normal radiations from A through a, it is evident that the radiations passing through this aperture from B, being oblique, are, when the bodies are of equal temperature, less than those of A passing through the same aperture, according to the well known law of radiations, that the intensity is proportional to the cosine of the angle between the ray and the normal to the radiating surface. It is seen that with sufficiently large value of u, it would be possible to overcome any difference of temperature however great.

In order to form an estimate of the amount by which the radiation from A to B exceeds that escaping from B through c, let us suppose that the temperature of A and B are equal and that the velocity v of the radiations, from both A and B is the same, and further, let the screen c be midway between a and b at a distance p from each. Let the problem be to compute the ratio between the radiations which pass through a given aperture, as c_1, from a_1 and from b_1 respectively, on the supposition that the heat radiates from the equal apertures a_1 and b_1 as from plane surfaces in the usual manner.

Suppose that the linear dimensions of the apertures are infinitesimal compared with p, and let the letters a_1 b_1 c_1 considered as numerical magnitudes designate the areas of the apertures a_1 b_1 c_1 respectively. Let θ be the angle between a ray and the normal to the surface from which it radiates. Let a sphere of radius p be supposed to be described about some point of b_1 as a center, and let s be the area of that part of its surface included within the cone of rays passing from the center to the periphery of the aperture c_1;

then
$$\frac{s}{p^2}=\frac{c_1}{r^2}\cos\theta \tag{1}$$

in which r is the distance passed over by the ray from b_1 to c_1.

Also
$$p=r\cos\theta \tag{2}$$

therefore
$$s=c_1\cos^3\theta \tag{3}$$

Now the heat radiated from b_1 is directly proportional to the area b_1, to the area s and to $\cos\theta$, but inversely proportional to p^2; hence

$$\frac{b_1 s}{p^2}\cos\theta=\frac{b_1 c_1}{p^2}\cos^4\theta \tag{4}$$

is proportional to the heat radiated from b_1 through c_1.

Similarly
$$\frac{a_1 c_1}{p^2} \tag{5}$$

is proportional to the heat radiated from a_1 through c_1 since it passes c normally. Now the heat passing from b_1 to c_1 must evidently move in a direction to overtake the aperture c_1, and to do this it must evidently take a direction such that θ is defined by the equation

$$\tan\theta=\frac{2u}{v},\ \text{or}\ \cos^2\theta=\frac{v^2}{v^2+4u^2} \tag{6}$$

Hence by comparing expressions (4) and (5), and substituting from (6) it appears that the heat radiated from a_1 through c_1 is greater than that radiated by an equal surface b_1 through c_1, in the ratio of $(v^2+4u^2)^2$ to v^4, in case the temperatures of a_1 and b_1 are equal. If the temperature of a_1 were lower than that of b_1 this ratio would be diminished; but by increasing u, the ratio can still be made to exceed unity, thus confirming the observations previously made. Neither is it essential that the radiations all take place at the same velocity. The reflectors can be arranged for some one velocity and they will then send back the radiations to B which have that velocity.

Perhaps the most simple ideal arrangement for effecting the proposed interference with the radiation naturally taking place between two bodies, is to suppose the apertures distributed around the circumference of equal circles upon three parallel disks fixed upon a common central axis, so that the plane of the paper in the figure becomes the surface of a circular cylinder, in which case the required velocity u can be given to the apertures by simple rotation. Let us, for brevity, call such an arrangement a *radiation syren*, or simply a *syren*, as it slightly resembles in its mechanical details the acoustic instrument called by that name.

Now, theoretically, no expenditure of energy is necessarry to preserve the uniform velocity of the moving parts of this syren, and once started with a sufficiently high velocity of rotation and proper adjustment of reflectors it would transfer heat from the body A to B regardless of their *temperatures*, provided no radiations are permitted except those perpendicular to the disks, excluding of course all radiations to and from all bodies other than A and B. It would also, as before shown, transfer heat from a colder body to a hotter, even though the radiation follow the general law of radiations from plane surfaces.

It is needless to state that the action of the syren, regarded as a possible physical process, is directly at variance with the hitherto accepted axioms and conclusions respecting the second law of thermodynamics.

It is true, we should at first thought be inclined to the belief that the laws of heat should suffer some modification, in case we assume differing rates of propagation not infinite, but we should hardly be prepared to admit the startling conclusions which must flow from such modification, if the physical process just sketched be admitted to be valid, and these I shall now proceed to develop.

I think it may be readily perceived that the axiom of Clausius, upon which he founds the second law, viz.: that "heat cannot of itself pass from a colder into a hotter body," when applied to radiations, implicitly assumes that the heat is radiated with infinite velocity, for it takes no account of the states of relative rest or motion of the bodies between which heat passes.

The axiom of Thomson, "it is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of surrounding objects," is obnoxious to the same criticism, and, as I have stated elsewhere,* these should not be called *axioms* at all, since we are not in a position to bring sufficient experience to bear upon them to affirm their validity or want of validity. Indeed, if the process of the syren be admitted to be possible, we are now in a position to assert that there exists an unexplained contradiction, which does not permit us to consider them as applicable to radiations of heat propagated at finite velocities.

What, it seems to me, the just quoted statements of Clausius and Thomson really asserted, was the historical fact, that at the date when they were made, no one had as yet invented any machine, or discovered any principle on which it was possible to construct a machine, which could successfully accomplish what these said had not been done; and it was further implied that no such machine could probably ever be invented nor any such principle discovered.

In complete accord with this statement is that of Kirchhoff, made in his lectures upon the Theory of Heat, during the summer semester of 1880, in which he said, if correctly reported, that the second law cannot be (at

*Thermodynamics, New York, 1879.

present) proved, but it, so far, has never been found in disagreement with experience.

It is well known that Maxwell has proposed a process to accomplish this very object, namely to transfer heat from a colder to a hotter body, in the following manner: If we suppose minute beings, endowed with senses sufficiently acute and having a corresponding agility, to guard minute openings in the diaphragm separating two portions of the same gas, which openings are only large enough for a single molecule to pass at once, they would be able without expenditure of energy to open and close the openings in such a way as to allow each molecule impinging at an opening to pass through or not, as they should choose. If they permitted only those molecules having more than the mean vis viva to pass in one direction and only those having less than the mean to pass in the opposite direction, then the gas on one side of the diaphragm would gain energy at the expense of that on the other side. That this process is actually at present beyond human ability does not show that we may not at some future time be able to accomplish what Maxwell proposed. If this be admitted, then the conclusions which I shall draw later from lack of generality in the second law of thermodynamics flow to a limited extent from the possibility of this process.

But Maxwell's process assumes the kinetic theory of gases as its basis, and stands or falls with it.

And if the second law is a necessary ultimate mechanical principle, holding for all bodies great and small, the above consequence of the kinetic theory of gases being in contradiction to the second law is fatal to the validity of the kinetic theory. But I do not now so regard the second law. I am compelled to regard it as merely an approximation in the case of radiations, and to regard it in general, with Maxwell and with Boltzmann,* as merely the mean result flowing from the laws of probability; though it had previously seemed to me possible to show it to depend upon fundamental considerations respecting the nature of heat as a form of energy, as was stated in my work previously referred to.

To avert to the consequences which are thus made to flow from the established fact of the finite velocity of radiant heat, we may mention that if the law of the dissipation of energy is no longer to be regarded as of universal validity, it being obviated by the process of the syren, it is just as possible to avail ourselves of the heat stored in cold bodies as in hot ones, and thus to employ the heat of a glacier to drive a steam engine, or to perform other like feats heretofore regarded as impossibilities. When I say it is just as possible, I do not imply that it is now just as practicable, or perhaps ever will be so.

That these observations are just, is seen when we reflect that the process of the syren simply heats a given body at the expense of any other, regardless of temperatures, by a method requiring the expenditure of no

*Weir. Sitzb. Band. lxxvi, lxxviii.

energy. It thus appears that it is possible to avail ourselves of the heat existing in bodies below the lowest thermometric levels of surrounding objects.

It may be objected that the syren renders a perpetual motion a possibility. That depends upon the definition of perpetual motion which we adopt. In the popular acceptation of that term, the process of the syren, as well as that of Maxwell, would make something near that possible. But when correctly viewed, the process of the syren does not imply the possibility of a perpetual motion, any more than does combustion or using the available energy of any chemical process.

It simply proposes to employ the finite amount of energy, existing in a given body in the form of heat, in a given way. It is admitted by all, that this heat could, a part of it, be made to do work by parting with some of it to a cooler body. The question is, whether this last part which has been imparted to the cooler body can be restored or transferred to the warmer body again without the expenditure of energy. Rankine evidently believed such a transfer possible, for in a paper on the "Reconcentration of the Mechanical Energy of the Universe,"* he has supposed it possible to reflect radiations in such a way as to give the universe such differences of temperature as to ensure it a new lease of life. Clausius, in his admirable paper on the "Concentration of Rays of Light and Heat,"† has shown the general impossibility of such a reconcentration as Rankine supposed, when the radiating bodies are at rest; nevertheless, no such impossibility may finally appear in case of the actual universe, which is a system of moving bodies.

The law of the dissipation of energy has been applied to the universe at large, and if the consequences which have been drawn from its supposed validity are to be regarded as no longer expressing a necessary law, then we are led to affirm that without change in the laws of nature as at present known to us, it is possible for increasing differences of temperature to be caused without the expenditure of energy, however improbable the supposition may be that such is the fact, and however improbable it may be that such differences are actually being caused on a scale sufficient to interfere in any practical way with the progress of the dissipation of energy as affirmed by Thomson, or check the increase of the entropy of the universe as stated by Clausius.

Still, it may be remarked, that a large part of the exchange of heat in the universe takes place in the radiant form; and it seems to me that it remains to be proved what the fact actually is, and consequently I must regard it as still an open question as to whether, on the whole, the available energy of the universe is being dissipated and its entropy increased or not.

Lest the foregoing remarks should be construed as in any sense undervaluing the splendid discoveries of Clausius, Thomson and Rankine in the

*Phil. Mag., Series iv, Vol. iv.

†Mech. Th. of Heat, Chapter xii.

domain of thermodynamics, let me disclaim such an interpretation entirely, and say that my only wish is to add, if possible, to the exactness and completeness of those theories, which are among the most important of modern physics.

Cincinnati, April 22d, 1882.

[NOTE.—Professor Willard Gibbs has suggested to me that we are not at liberty to assume that reflections or radiations taking place at moving surfaces, follow the same laws as from surfaces at rest; and that a perfect reflector moving in a medium through which luminous waves are being propagated, may suffer a resistance which would require the expenditure of as much energy as could be obtained by the proposed process. Admitting for the moment the justness of these observations respecting reflections and radiations from moving surfaces, I shall hope to show in the first place that the syren may be so adjusted that no such resistance need be encountered, and in the second place that it is possible so to modify the syren that no reflections or radiations need take place from moving surfaces.

In the discussion of the first point, let us consider the case of a ray falling perpendicularly upon a perfect reflector. The only numerical magnitudes susceptible of variation in this radiation are its wave length and amplitude, the velocity being assumed constant and dependent upon the elasticity of the medium. When the reflector moves in its own plane at right angles to the ray, it cannot, apparently, be seriously urged that the reflected ray will have either its wave length or its amplitude changed by the reflection. For, so far as can be seen, the wave length would suffer a change and be shortened only by giving the reflector a motion towards the approaching ray, thus crowding the waves together. Neither would the amplitude be changed, for to do this would require the moving plane to impart tangential impulses to the ether such as can be compounded with the transverse motions already existing. If such be the tangential action of the moving plane on the ether, we should be led to the apparently inadmissable result, that since a moving plane may impart tangential impulses to the luminiferous ether, a disk rotating with sufficient velocity in vacuo would become self-luminous. It would seem but reasonable in our present imperfect knowledge of the subject to conclude that the only resistance which a perfect reflector experiences, while moving against a ray, is normal to its surface, and to be represented by a normal pressure. Even if this view be not regarded as entirely correct, it may nevertheless be confidently affirmed that the tangential must be small compared with the normal resistance, just as the fractional resistance of a gas is small compared with that arising from direct pressure upon a body moving through it. Hence, it is seen, that in spite of friction it is possible to make a ray turn a mill whose vanes are perfect reflectors in the same manner as the wind turns a windmill; and the energy expended will in that case be withdrawn from the ray itself.

Now the rotating screen c of the syren may be regarded as such a mill, the surfaces of whose vanes may be so inclined as to return radiations coming from B partly to apertures in front of those from which they emanated and partly to those behind, so as to exert no force either to accelerate or retard c.

Should, however, energy be expended in moving c against the reflected ray, this energy must exist immediately after the reflection in the reflected ray and be transmitted by it to B. Hence we are led to the following remarkable result:—on the hypothesis that radiations cause pressure at surfaces at which they suffer total reflection, a part of the energy of the radiation may be expended in moving the reflector against a resistance while the remainder is all reflected to the body from which it emanated. It is to be noticed that this process of the *reflecting mill* or *mill* as it may be called for brevity, is, if possible, in more pronounced and unequivocal contradiction to the second law than that of the syren.

For the latter calls in question the accepted law of mutual exchanges and the second law as depending upon it, but the former applies to a single body alone as B, and a moving reflector. For example, let B have no radiations except those through the apertures b, then if that part of its radiations which are not expended in turning c are returned to it, it is possible for the mill c to be turned by radiations from B until the energy of B is all expended in performing work, thus withdrawing all heat from B while no heat has been transferred to any other body in the manner required by the second law, and this regardless of the temperature of surrounding objects. It therefore seems to me that the supposition of a pressure at reflecting surfaces is more directly opposed to the second law than that of no pressures.

In regard to the second point mentioned, it seems quite possible to construct a syren such that the reflections in it shall all take place from stationary surfaces, or from those whose velocity differs from zero by less than any assignable quantity. For let the mean velocity u of the screens be the same as before, but not continuous. Instead, let it consist of sudden steps forward, each of which is half the width of an aperture. The possibility of a mechanical arrangement which could effect this motion, without expenditure of energy, with the aid of perfect springs, fly-wheels, detents, etc., to any required degree of approximation will, I think, be admitted, certainly by any one who can admit that Maxwell's "sorting demon" expends no energy in opening and closing apertures.

It will be seen that the reflections all take place from screens at rest (or nearly so) in this modified syren, and that the same transmissions occur through its apertures as have heretofore been supposed to take place.

I am not inclined, however, to insist on the special kind of apparatus which I have proposed for rendering sensible the phenomenon which I believe to exist during the time in which the radiations are in process of becoming established, as contemplated in the ordinary law of thermal ex-

changes. The point to which I would emphatically direct attention is that since radiations are known to be moving in space apart from ponderable bodies and subject to reflections, it is possible so to deal with them as to completely alter their destination and successfully interfere with all results flowing from Prevost's law of exchanges. It also seems to me that the exactness of the second law of thermodynamics depends, as far as radiations are concerned, upon that of this law of exchanges.

Cincinnati, May 18th, 1882. H. T. E.]

Revision of the Dermestid æ of the United States. By Horace F. Jayne, M. D.
(With four Plates.)

(Read before the American Philosophical Society, June 16th, 1882.)

Many years have elapsed since the small family of Dermestidæ, as represented in our fauna, has received careful study. The addition of new genera and species, and the confusion existing among those already well established, have suggested that a review of the entire field, in the light of modern entomological progress, would be useful to the student. In the following pages differences of structure have been recognized, as far as possible, as the only true and constant characters by which to separate species. The arrangement of genera is, substantially, that already well known, save only the necessary alterations incident to the introduction of two new genera. The specific classification is, almost entirely, original. Dr. LeConte, in addition to very many other favors, has kindly offered, in my absence, to read the proof of the following pages.

DERMESTIDÆ.

Head variable in size, deflexed; front variable in width, a single ocellus, or simple lens, at middle, except in Byturus and Dermestes; epistoma usually very short, coriaceous, on the same plane as the front except in Axinocerus, in which it is long and retracted; labrum distinct, mandibles short, simple, except in Byturus in which they are dentate, maxillæ with the base exposed, with two lobes of variable form, palpi small, slender, four-jointed; mentum quadrate, usually corneous; ligula simple, palpi three-jointed. Eyes usually prominent—exceedingly in Byturus—moderately coarsely granulated, rounded, entire, except in certain species of Trogoderma, Anthrenus and Orphilus, where they are more or less deeply emarginate in front.

Antennæ inserted in front of the eyes, usually eleven-jointed, variable in Anthrenus, nine-jointed in Dearthrus, ten-jointed in a foreign genus, Hadrotoma; terminated by a large club, which is quite strongly serrate

in Acolpus and Trogoderma ; made up, usually, of three joints, of a variable number of joints, however, in Perimegatoma, Acolpus, Trogoderma, and Anthrenus, of two joints in Cryptorhopalum and some foreign genera, and of one, enormous, securiform joint in Axinocerus.

Prothorax short, with side pieces not separate, excavated beneath for the reception of the antennæ, except in Byturus, Attagenus, Dearthrus, Perimegatoma, Acolpus, and one foreign genus—Trinodes. In Anthrenus the antennal fossæ divide the anterior part of the lateral margin ; coxal cavities large, transverse, closed behind by the mesosternum, except in Byturus ; prosternum prolonged behind and usually lobed in front.

Mesosternum narrow and entire in Byturus and Dermestes ; narrow and emarginate in front, or entirely divided, in Dearthrus, Perimegatoma and two foreign genera—Megatoma and Hadrotoma ; wide and entire in Apsectus and Orphilus ; wide and deeply emarginate, or entirely divided in the remaining genera ; metasternum short, rounded or truncate in front or narrowly produced between the mesocoxæ ; side pieces wide, except in Byturus. Elytra covering the abdomen, not striate, except faintly in certain species of Dermestes. Sides more regularly oval in the females ; epipleuræ not extending beyond. Abdomen with five free ventral segments.

Anterior coxæ conical, prominent, with small trochanter ; middle coxæ oval, oblique, excavated externally, with large trochantin—usually distant, approximated in Byturus, Dermestes, Attagenus, Dearthrus, Perimegatoma and two foreign genera—Megatoma and Hadrotoma. Posterior coxæ slightly separated, transverse, not extending to the margins of the body, except in Orphilus, dilated into a plate partly protecting the thighs. This coxal plate shows a beautiful series of variations ; in Byturus it is almost obsolete ; in Dermestes and Attagenus very long, narrow, obliquely truncate externally ; covering only the basal half of the femur ; in genera from Dearthrus to Apsectus, inclusive, it is moderately long and wide, covering more than the basal half of the femur, not obliquely truncate externally, while in Orphilus it is short and wide, covering the anterior part of the femur for its entire length.

Legs short, somewhat contractile, tibiæ with distinct stout spurs ; tarsi five-jointed, pubescent, except in Byturus, where the second and third joints are lobed beneath, first joint either short or long, equaling the fifth, 2–3–4 always short, fifth always long, claws simple, except in Byturus, in which they are dentate.

Two sub-families may be thus separated :

Tarsi with second and third joints lobed beneath, claws strongly toothed at base, mandibles toothed. Anterior coxal cavities closed behind by the prosternum..... **BYTURIDÆ.**

Tarsi, claws, and mandibles simple. Anterior coxal cavities completed behind by the mesosternum... **DERMESTIDÆ.**

SUB-FAMILY I.—BYTURIDÆ.

BYTURUS, Latr.

Head very large, front as wide as long; no frontal ocellus. Mandibles furnished with several teeth; eyes very prominent, very large, coarsely granulated, round, entire; epistoma very short; antennæ 11-jointed, terminated by a three-jointed club. Thorax nearly as long as wide, anteriorly more than half as wide as at the base, which is somewhat bisinuate, disc convex; sides flattened, especially posteriorly, arcuate; hind angles rounded. Scutellum large, quadrate. Elytra three times as long as wide; sides sub-parallel, apical angles acute. Prosternum very short and wide, not lobed in front, tip narrowly and sharply produced; continuous around and behind anterior coxæ, enclosing them. Anterior coxæ prominent, slightly separated by the top of the prosternum. No antennal fossæ, spaces between prosternum and lateral margins broad, slightly concave. Mesosternum entire, broad and long, prolonged narrowly behind between the middle coxæ which are almost approximated. Metasternum short, side pieces wide (fig. 1).* Legs stout, femora attaining sides, slightly grooved beneath for the reception of the tibiæ, tibiæ stout, terminal spurs strong. First joint of tarsus triangular, 2–3 prolonged beneath into a membranous lobe, 4 small nearly concealed by 3, 5 as long as the four preceding together; the terminal claws are armed with a large basal tooth (fig. 3).

This genus, which is represented by two species—one from the Atlantic district and one from the Pacific—differs greatly from all the rest of genera in the family by the toothed mandibles, the absence of antennal fossæ; the anterior coxal cavities completed behind by the prosternum; the exceedingly large entire mesosternum, the feebly developed posterior coxal plates, the tarsus with second and third joints lobed beneath, and by the strong tooth of the ungues. There can be no doubt as to the position of this genus; its affinities with the rest of the Dermestidæ are marked. Erichson, however, placed it in the Melyridæ, DuVal among his Telmatophilidæ and Crotch in the Nitidulidæ. Redtenbacher and Lacordaire assign it to the present family.

Our two species may be distinguished as follows:—

Elytra uniformly light brown; antennal club compressed, second and third joints much wider than long; eyes very large aud prominent; thorax coarsely punctate.... **unicolor.**

Elytra marked by three transverse black bands; antennal club elongate, second and third joints fully as long as wide; eyes smaller, less prominent; thorax finely punctate.... **grisescens.**

* The posterior coxæ are short and wide, but do not attain the sides, the coxal plates are very feebly developed, not covering the femora (fig. 2).

B. unicolor Say. Elongate, moderately convex, light brown, clothed with moderately long, semi-erect, yellow-cinereous pubescence; elytra uniformly light brown; head coarsely punctate, sparsely pubescent; eyes very large and prominent, black; antennæ nearly as long as the thorax, 11-jointed; first joint, large, round; second smaller; 3–8 decreasing gradually in size, wider than long; 9–10 subequal; 11 longer and rounded at tip; the last three joints forming a somewhat compressed club, which equals one-third the entire length of the antennæ; thorax brown, coarsely and densely punctate, pubescence long, dense at sides; scutellum glabrous; elytra uniformly brown, very coarsely and densely punctate, covered with moderately dense, long, semi-erect, yellow-cinereous hairs; body beneath also brown, pubescence short and recumbent; legs testaceous. (Figs. 1, 4.) Length 18 inches; 4.5mm. Habitat, Atlantic region.

B. grisescens Lec. Elongate, moderately convex, brown, covered with moderately dense, long, recumbent, yellowish-gray pubescence, antennæ, legs, and abdomen rufo-testaceous; elytra light brown marked with three broad transverse bands of black; head finely and sparsely punctate; eyes moderately large and prominent; antennal club elongate, second and third joints as long as wide; thorax finely and densely punctate; elytra moderately coarsely and densely punctate, brown, marked with three equally separated transverse black bands, of which the first is the faintest, and directed obliquely backward and outward, the second wider and darker, also directed backward and outward, but with a large sutural light brown spot; the third or apical band is distinct and directed forward and outward (Figs. 5, 6).

Length 12 inches; 3 mm. Habitat, California.

A smaller and darker species easily recognized by the characters already given.

Sub-Family II.—Dermestidæ (Genuini).

This sub-family, which is distinguished by the characters already given, is represented in our fauna by the following genera:

No frontal ocellus..... **DERMESTES.**
Frontal ocellus distinct.
  Mesosternum narrow, middle coxæ not widely separated.
    Prosternum simple in front.
      Antennæ 11-jointed, mesosternum only deeply sulcate anteriorly, posterior coxal plate long, obliquely truncate externally..... **ATTAGENUS.**
      Antennæ 9-jointed, mesosternum narrowly divided, posterior coxal plate short, not obliquely truncate externally.... **DEARTHUS.**
    Prosternum lobed in front..... **PERIMEGATOMA.**

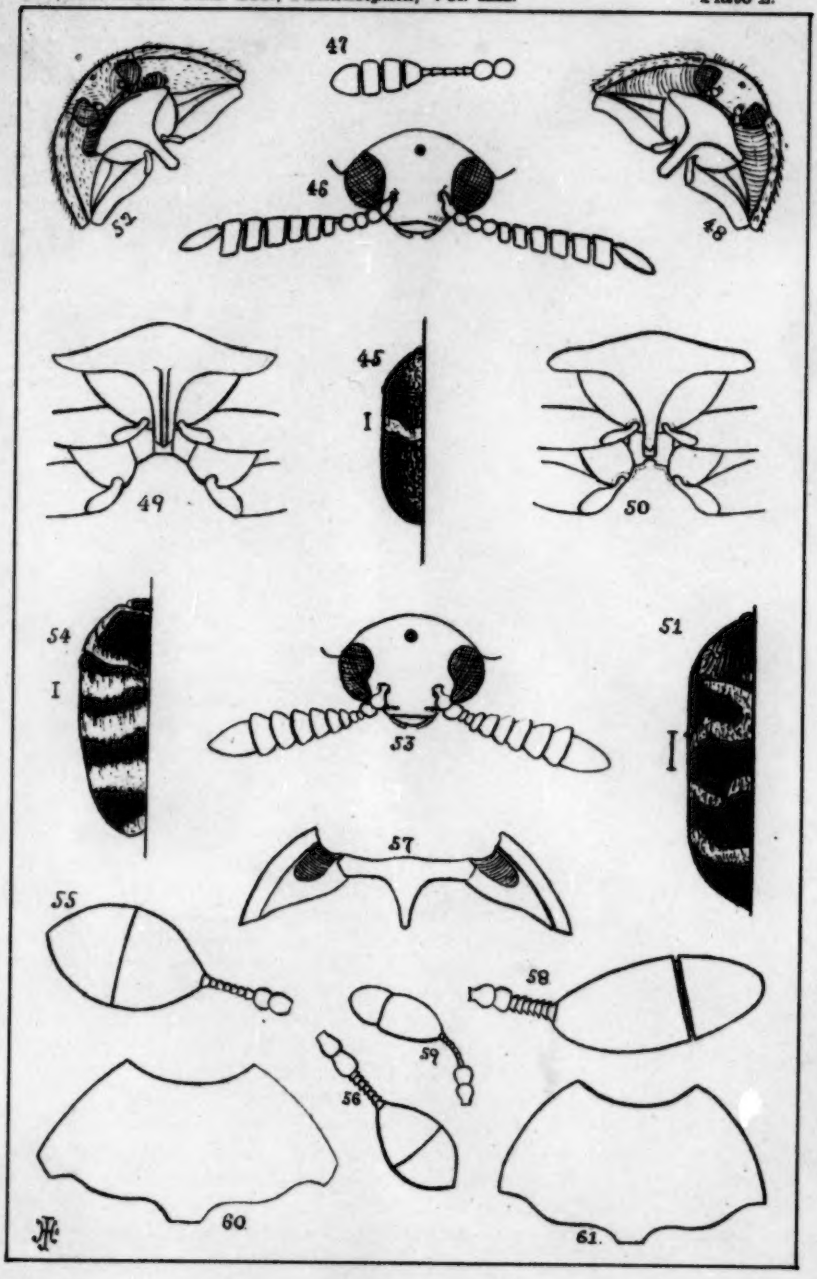
ERRATUM.

Page 474, line 24, after *Meles*, insert *Helictis*.

Page 474, line 25, omit *Helictis*.

Page 474, line 27; remove *Æluropoda* and *Hyænarctos* from ÆLURIDÆ, and insert under URSIDÆ (line 28) the names *Æluropoda* and *Hyænarctos*.

Page 475, foot-note, for vig. read Vig.



DERMESTIDÆ.

Mesosternum broad, emarginate in front or entirely divided, receiving the tip of the prosternum, middle coxæ widely separated.
Mandibles and labrum not covered by the prosternum.
No antennal fossæ..... **ACOLPUS.**
Antennal fossæ distinct..... **TROGODERMA.**
Mandibles covered, labrum not covered by the prosternum.
Antennal fossæ under lateral margin of thorax. Body pubescent.
Front rather flat, clypeus continuous on the same plane. Antennal club of at least two joints ..... **CRYPTORHOPALUM.**
Front convex between the eyes, clypeus forming an angle with the front, retracted. Antennal club of one large, broadly securiform joint..... **AXINOCERUS.**
Antennal fossæ dividing the anterior part of the lateral margin of the thorax. Body clothed with scales..... **ANTHRENUS.**
Mesosternum broad, entire. Middle coxæ widely separated. Mouth parts covered by sternum, prosternum truncate behind. Posterior coxæ not prominent, not reaching the sides. Body covered with very long, erect hair..... **APSECTUS.**
Mouth parts covered by anterior legs, prosternum pointed behind. Posterior coxæ attain the sides. Body naked, shining.. **ORPHILUS.**

DERMESTES Linn.

The species grouped together in this genus are the largest and most conspicuous of the entire family. They are all elongate in form, black, more or less pubescent. The head is small and can be retracted within the thorax; the eyes large and, in all our species, entire. No frontal ocellus. The antennæ are 11-jointed, the last three joints being large, prolonged on their outer side, and forming an irregular club (fig. 7), which does not differ either in the species or sexes. The thorax in the first group —including six species—is very convex in front, and the anterior portion of the lateral margin cannot be seen from above, while in the second group—*pulcher*, *lardarius*, *cadaverinus* and *elongatus*—it is less convex, the entire lateral margin being visible. The base is broadly lobed; in the first group, impressed with a median fovea, conspicuous in *marmoratus*, hardly apparent in *fasciatus;* in the second group with two, widely sepa-

rated, basal pits, thus linking this genus, and through it the entire family, with the *Mycetophagidæ*. The thorax is either covered with mixed brown, black and white pubescence, or is uniform in coloring; *mucoreus* and *vulpinus* have a large median triangular naked space on the upper surface. The scutellum is small, but distinctly visible. The elytra are elongate, sides slightly rounded, except in *elongatus*, where they are sub-parallel; pubescence quite dense, except in *pulcher* and *mucoreus*. The prosternum is very short, not lobed in front, prolonged behind into a short, acute point, not reaching beyond the anterior coxæ, which are large and almost contiguous. The antennal fossæ, moderately deep and well defined, are situated transversely in the anterior half of the spaces between the prosternum and lateral margins (fig. 8). The mesosternum is entire, narrow and short, not reaching beyond the middle of the meso-coxæ, which are not widely separated, the metasternum being prolonged anteriorly to meet it. The latter is short, the side pieces wide. The posterior coxæ do not attain the sides of the body, and the coxal plates are long and narrow, covering the basal half of femora, obliquely truncate externally (fig. 9). The abdomen is clothed with dense whitish pubescence (except in *pulcher*, *bicolor* and *cadaverinus*), and then bears a row of black spots on each side, except in *sobrinus*, which has two such series. The males have the third and fourth ventral segments marked by a small median pit, from which arises a bunch of brown, erect hairs. The male of *vulpinus* however, has only the fourth segment so characterized. The legs are stout, the femora, in the species of the first group already referred to, annulated at middle with white pubescence, but *mucoreus* has the basal half of thighs covered with white hairs. The first four joints of the tarsi are equal, the fifth as long as all the preceding taken together.

The species may be separated by means of the following table:

I. Males with third and fourth ventral segments each marked by a median pit from which arises a bunch of erect brown hairs.
Anterior portion of lateral margins of thorax not visible from above. Base with median puncture.
Femora annulated with white pubescence, thorax entirely pubescent.
Pubescence on upper surface variegated, a single series of lateral black spots on abdomen.
Elytra with broad basal band of yellowish cinereous pubescence..... **marmoratus.**
Elytra with broad sub-basal band of yellowish cinereous pubescence..... **fasciatus.**
Elytra marmorate;
With yellowish cinereous and black pubescence. Scutellum not conspicuously lighter..... **murinus.**
With dark bluish cinereous, ochre and black pubescence. Scutellum conspicuously lighter... **talpinus.**

Pubescence on upper surface uniform, two series of lateral black spots on abdomen..... **sobrinus.**

Femora with basal half clothed with white hairs. Elytra with broad basal rufous band, thorax with a large triangular naked spot at middle ..... **mucoreus.**

Entire lateral margin of thorax visible from above. Base with two punctures. Legs not annulated.

Thorax and base of elytra red, covered with orange-red pubescence ..... **pulcher.**

Basal portion of elytra rufous, bearing yellow pubescence, including three black spots..... **lardarius.**

Thorax and elytra uniform in color, very elongate, striæ on elytra distinct, pubescence on abdomen cinereous, no series of lateral black spots..... **elongatus.**

Not markedly elongate, striæ on elytra very faint, pubescence on abdomen white, and series of lateral black spots..... **cadaverinus.**

II. Male with the fourth ventral segment marked by a median pit. Anterior portion of lateral margins of thorax not visible from above. Color above uniform. Thorax with a large triangular naked spot at middle. One series of lateral black spots on abdomen. Legs not distinctly annulated..... **vulpinus.**

D. marmoratus Say. Oblong, convex, black, quite densely pubescent. Elytra black, mottled with ochre, black and cinereous pubescence, and bearing a large sub-quadrate spot just behind the base of cinereous. Head finely but densely punctate, pubescence semi-erect, dense, variegated, brown, black and white. Antennæ piceous, club fulvous. Thorax very convex anteriorly, basal half of lateral margin visible from above, sides suddenly narrowed at middle, finely and densely punctate, a deep fovea in middle of base, pubescence dense, variegated as on head, two lateral and a median small triangular white spots. Scutellum covered with sparse cinereous hairs. Elytra densely and finely punctate, faint striæ near apex, mottled with small transverse spots of fine recumbent brown, black and cinereous pubescence. A large irregularly quadrilateral cinereous spot on outer side just behind the base, the inner anterior angle of which is prolonged inward and forward to the scutellum. Body beneath black, clothed with long dense white recumbent hairs. Abdomen with a row of yellowish-black spots on either side. Last segment black, sparsely covered with fulvo-cinereous pubescence. Legs covered with dull brownish hairs, femora annulated at middle with white. Length .46 inch; 11.5 mm. (Fig. 10).

The largest species of the genus, and indeed of the entire family, which is found in our fauna. The large distinct basal, and the faint general cinereous spots on the elytra, the convex thorax, annulated femora, black

spots on abdomen are the characters upon which to rely for a correct diagnosis. *Dermestes mannerheimi* Lec., appears to be only a variety in which the basal elytral spots are shorter and more confluent, while the transverse spots at middle and apex are wider and more distinct.

Occurs in the Western and Pacific States.

D. fasciatus Lec. Elongate, black, convex, quite densely clothed with black and cinereous pubescence. Elytra with a moderately broad sub-basal band, fine transverse mottlings of cinereous pubescence. Head moderately coarsely, densely punctate, pubescence semi-erect, dense, variegated fulvous and black. Antennæ piceous, club fuscous. Thorax very convex, lateral margins not visible from above, sides arcuate, densely and finely punctate, only a very slight depression at the middle of the base; pubescence dense, variegated, brown, black and cinereous. Scutellum covered with long, fulvo-cinereous, recumbent hairs. Elytra finely and densely punctate, striæ hardly apparent, pubescence black, marmorated with small, cinereous, transverse spots; a broad transverse band which does not reach the base also cinereous. Body beneath clothed with dense yellowish-white, recumbent pubescence, a single series of lateral black spots on abdomen, last segment black, except three white spots at base. Legs covered with dense brown hairs, femora annulated at middle. Length .32 inch; 8 mm. (Fig. 11.)

No difficulty will be encountered in recognizing this species; the broad, distinctly limited, transverse elytral cinereous band, which never attains the base, is characteristic.

Occurs in Colorado.

D. murinus Linn. Elongate, black, clothed with fine black and cinereous pubescence. Elytra black, covered with marmorate black and cinereous hairs. Head densely and moderately coarsely punctate, clothed with dense variegated hairs. Antennæ piceous, club fuscous. Thorax very convex in front, lateral margins not visible from above, sides arcuate; finely but densely punctate, a faint median basal depression, pubescence dense, variegated, a small white spot at middle. Scutellum clothed with cinerous hairs. Elytra black, densely and finely punctate, striæ indistinct, marmorate with fine sparse black, and coarser cinereous pubescence, the latter more dense at base. Body beneath black, clothed with long, dense, whitish yellow pubescence, abdomen with a row of black spots on each side, last segment black, marked with two white spots at base. Legs brown, femora annulated at middle with white. Length .22 inch; 8 mm. (Figs. 12, 13.)

This species is to be distinguished from the preceding by the irregularly mottled cinereous and black pubescence on the elytra, there being no distinct basal or sub-basal band. Two varieties can be recognized.

Variety a. In this the cinereous spots at the sides of the base of the elytra are confluent, the entire basal half appearing yellowish-white, except some black marking near the suture. (*Caninus* Germ.)

Variety b. The pubescence on the elytra is cinereous, faintly mottled with black. This form is smaller and more slender than the preceding, and was described by Dr. LeConte under the name *rattus*. I cannot, however, see anatomical characters by which it can be distinguished, the color of the pubescence not being sufficient, as all gradations through the first variety, up to a typical *murinus* are to be found.

Occurs in the Middle and Western States.

D. talpinus Mann. Elongate, convex, black, clothed with fine black recumbent hairs. Elytra black, covered with black pubescence, which is mottled with coarser ochre and gray. Head coarsely punctate, pubescence long, semi-erect, variegated. Antennæ fuscous. Thorax convex, anterior part of lateral margin not visible from above, sides arcuate; a not very distinct depression on base, finely and densely punctate, covered with bunches of variegated hairs. Scutellum clothed with coarse, recumbent, golden-yellow pubescence. Elytra black, densely and finely punctate, marked by a few faint striæ, pubescence black, marmorate with very small, transverse spots of ochre and gray. Body beneath clothed with long, recumbent, grayish-white pubescence, and a single series of lateral black spots on abdomen. Last segment entirely black, except two faint white spots, at base, on each side of median line. Legs clothed with brown pubescence; femora annulated at middle with white. Length .26 inch; 6.5 mm.

This species is to be distinguished from the foregoing mottled forms, by the almost black color of the pubescence on the elytra, and by the conspicuously yellow scutellum.

Occurs in the Pacific States.

D. sobrinus Lec. Elongate, convex, black, covered with short, sparse, fuscous pubescence. Elytra uniformly black, pubescent. Head moderately coarsely and densely punctate. Antennæ testaceous. Thorax convex, anterior part of lateral margin not visible from above, sides suddenly narrowed at middle, a very faint depression at middle of base, hind angles prominent, faintly and densely punctate, entirely pubescent. Scutellum densely punctate. Elytra finely and densely punctate, faint striæ just apparent, pubescence sparse and unicolored. Body beneath covered with long, dense, white, recumbent pubescence. Abdomen marked by two lateral and two sub-median longitudinal rows of spots of black pubescence. Legs clothed with dense brown hairs; femora annulated at middle with white. Length .32 inch; 8 mm.

The distinguishing characters of this species are found in the convex thorax, the uniform color of the pubescence on the upper surface, the four rows of abdominal spots and the annulated femora. Occurs in Texas—one specimen in Dr. LeConte's cabinet.

D. mucoreus Lec. Elongate, moderately convex, black, clothed with sparse black and cinereous pubescence. Elytra black, with a broad irregular

basal band rufous, which bears sparse reddish-yellow hairs. Head moderately coarsely and densely punctate, pubescence cinereous and dense. Antennæ piceous; thorax very convex anteriorly, anterior two-thirds of lateral margin invisible from above, sides arcuate, basal fovea indistinct; finely and densely punctate, covered at sides, base and front with cinereous pubescence, leaving a large triangular spot at middle naked. Scutellum black, sparsely pubescent.

Elytra black, basal third rufous, bearing an irregular transverse band of yellowish hairs; pubescence black, with a transverse spot on each side of suture, at middle, and some faint mottlings; cinereous, under surface clothed with dense, white hairs. Lateral spots on abdomen distinct; last segment white, legs sparsely pubescent, except the basal half of femora which is covered with dense white hairs. Length .28 inch; 7 mm.

A number of specimens received by Dr. Horn from Texas, on comparison with the type in Dr. LeConte's cabinet, prove to be of this species. The original description was of an immature form from an uncertain locality. The characters to be relied upon are the convex, naked at middle, thorax, with uniformly cinereous pubescence, faint basal puncture; the elytral rufous band; and the femora white at base.

D. pulcher Lec. Elongate, moderately convex, red, covered with sparse, short, recumbent, golden pubescence. Elytra black, except a narrow basal band, which is red. Head finely and moderately densely punctate. Thorax only moderately convex, lateral margins entirely visible from above, gently arcuate, base broadly lobed, two distinct basal foveæ on each side of lobe, hind angles prominent; finely and densely punctate. Elytra densely, moderately coarsely punctate; a few faint striæ indicated near apex, black, covered with very sparse, fine, black pubescence, except the base which is red, clothed with golden hairs. Scutellum punctate. Entire under surface (also antennæ and legs) red, finely punctate, pubescence fine. Length 25 inch; 6.2 mm. (Fig. 16.)

No trouble will be found in distinguishing this species; the general red color, with the almost entirely black elytra, the flattened thorax, with two basal foveæ; the absence of abdominal spots and white rings on femora, furnish conclusive characters.

Occurs in the Southern, Middle and Western States.

D. lardarius Linn. Elongate, moderately convex, black or piceous, clothed with short black sparse recumbent pubescence. Elytra marked at base with a broad rufous space which is covered with cinereous yellow and three spots of black pubescence. Under surface and legs black with yellowish pubescence, without spots or rings. Head moderately coarsely but very densely punctate, antennæ rufous. Thorax moderately convex, lateral margins entirely visible from above, basal fovea not very deep; finely, but very densely punctate, pubescence black, scutellum covered with black pubescence. Elytra finely, but very densely, punctate, indistinct striæ near apex, black with a space at base rufous which bears yellow

hairs and a transverse row of three black spots at the basal third. Length .24.–30 inch; 6–15 mm. (Figs. 14, 15.)

The most common of all the species; to be recognized by its more elongate form, basal band of cinereous pubescence on elytra, and the uniform color of the hair on the under surface. A rubbed specimen bears some resemblance to *mucoreus*, but the important characters on the thorax and under surface of the latter, already given, would separate it at once.

Dermestes signatus Lec. is a variety in which the thorax is covered with denser cinereous pubescence, marked by three small black spots on disc, and the elytra almost entirely piceous, the cinereous pubescence extending nearly to the apex. A well furnished cabinet exhibits a complete series of gradations from the typical *lardarius* down to the variety under consideration.

Occurs everywhere.

D. elongatus Lec. Elongate, cylindrical, black or piceous, covered with moderately long, dark brown, recumbent pubescence. Elytra uniform in color, arcuate, marked by striæ. Antennæ, legs and under surface piceous. Head moderately coarsely punctate. Thorax only moderately convex, sides gently arcuate, slightly margined, finely and densely punctate, two not very distinct basal foveæ. Elytra black, finely and densely punctate, eight or ten distinct striæ from base to apex, under surface and legs covered with uniform dark cinereous pubescence. Length .36 inch; 9 mm. (Fig. 17.)

The most elongated of all the forms under consideration, with the striæ on the elytra more apparent. The uniform pubescence and absence of markings on legs and abdomen are important additional characters. This species may be identical with *bicolor*, but from the description the form seems less elongated and the striæ deeper in the latter. A comparison of types would alone settle the matter. I have preferred to keep them, temporarily, at least, separate.

Occurs in the Southern and Western States.

D. cadaverinus Fabr. Elongate, moderately convex, black or piceous, clothed with sparse, short, recumbent, cinereous pubescence. Elytra black. Under side, legs and antennæ piceous. Head black, densely and moderately coarsely punctate. Thorax black, lateral margins arcuate, entirely visible from above; base lobed, with two very distinct basal foveæ, densely, moderately coarsely punctate, with faint striæ on apical portion. Body beneath more densely pubescent. Abdomen without black spots at sides; legs not annulated. Length .27 inch; 6.7 mm.

This species is to be distinguished by the uniform color of thorax and elytra and of their pubescence, by the deep thoracic foveæ and only faint apical striæ on elytra.

Occurs in Florida.

D. vulpinus. Elongate, black, convex, clothed with sparse cinereous pubescence. Elytra uniform in color. Head densely, moderately coarse-

ly punctate. Antennæ rufous. Thorax very convex in front, lateral margin not visible from above, finely and densely punctate, no distinct basal foveæ, pubescent only at sides and front, leaving a large triangular median space, naked. Scutellum clothed with orange-yellow hairs. Elytra black, finely and densely punctate, hardly any appearance of striæ, covered with sparse, cinereous, semi-erect pubescence. Body beneath clothed with long dense white hairs, a row of black spots on each side of abdomen, the fourth segment alone marked by a median pit, which bears a bunch of brown hairs; last segment brown, except two white spots on either side of median line. Legs covered with brown hair. Femora not distinctly annulated. Basal half almost entirely yellowish-white. Length .36 inch; 9 mm.

The male of this species can be recognized at once by the single abdominal pit on the fourth segment; the female by the convex, naked at disc, thorax; the uniform color of the upper surface, and the abdominal spots and indistinct markings on femora, which are important characters, common to both sexes.

ATTAGENUS Latr.

Head small, front wide and flat, ocellus distinct. Epistoma short. Eyes round, entire, moderately prominent. Antennæ eleven-jointed, terminated by a three-jointed club, which varies greatly in the different species. Mouth parts not protected by prosternum, thorax convex, at base not quite twice as wide as long, apex half as wide as base, which is strongly bisinuate, sides arcuate, hind angles prominent. Scutellum small, but distinct. Elytra elongate, moderately convex, apices hardly separately rounded. No antennal fossæ, prosternum not lobed in front, broad and moderately long, except in *varicolor*, in which it is narrow and short, prolonged behind into a tip which is acute, and extends slightly beyond the anterior coxæ. Mesosternum narrow, moderately long (very long in *Hornii*), sulcate anteriorly, mesocoxæ not widely separated. Posterior coxal plate very long, prominent, narrow, obliquely truncate externally. Legs stout, femora channeled beneath for tibiæ; first joint of tarsi very short, 2–5 successively larger.

The distinguishing characters of this genus are the narrow, emarginate mesosternum, prosternum simple in front, the 11-jointed antennæ and absence of antennal fossæ, and the long prominent hind coxal plate.

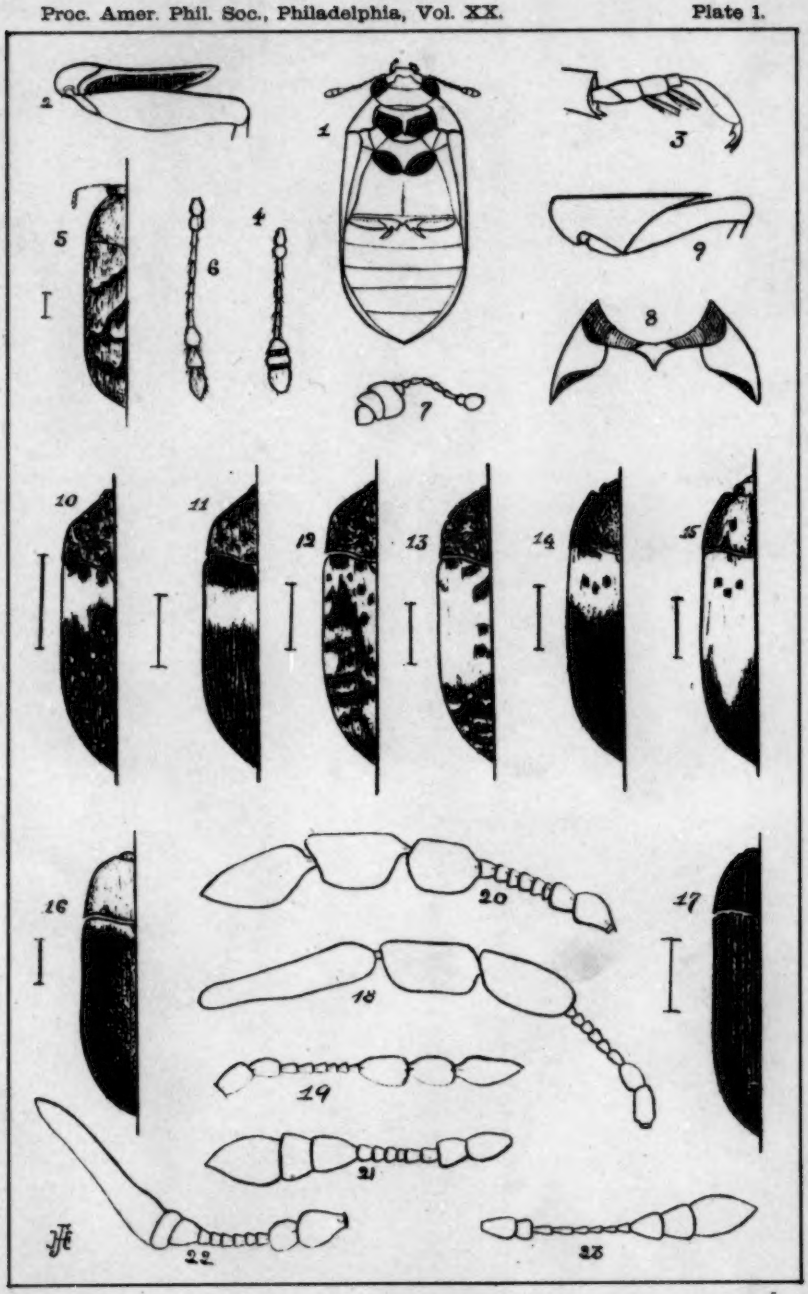
The following table is put forth to aid in separating our species:

Prosternum broad, moderately long.

Elytra uniformly black or piceous. Last joint of male club four or five times as long as the preceding two united, which are very small.

Pubescence on elytra uniformly dark and sparse..... **piceus.**

Pubescence on elytra dense and white on a smooth spot at middle, on each side of suture..... **pellio.**



DERMESTIDÆ.

Elytra fulvous, with a black sub-basal spot and longitudinal broad band on either side of suture extending almost to the apex, pubescence uniformly cinereous. Last joint of male club as long as the preceding two united, which are very large and equal. ..... **Hornii.**

Elytra black with a sub-basal sinuous transverse piceous band, which bears dense whitish pubescence, all three joints of male club very large and equal. ..... **perplexus.**

Prosternum narrow and short.

Elytra black, with three, more or less confluent, broad piceous spots on either side of suture; whitish pubescence arranged in three distinct transverse fasciæ, all three joints of male antennæ club very large and equal. **varicolor.**

A. piceus Oliv. Elongate, convex, black, clothed with short, semi-erect, yellow pubescence. Head coarsely punctate, sparsely pubescent. Antennæ rufo-testaceous. Thorax black, coarsely punctate, pubescent at sides and base. Scutellum pubescent. Elytra black, or rufous, coarsely punctured, clothed with very sparse, brownish pubescence. Body beneath black, coarsely and densely punctate, clothed with semi-erect, yellow hairs. Prosternum long and wide. Legs rufous. Length .14–.20 inch; 3½–5 mm. (Fig. 26.)

Male. Antennæ with first joint large, suboval; second smaller; joints 3–8 small; 9–11 forming the club, of which the first two joints are wide but very short, the last wide, extremely long, pointed at end—equaling all the preceding part of the organ. (Fig. 22.)

Female. Antennal club compact, not quite equal to all the preceding joints, made up of three joints, of which 9–10 are equal; while the last equals the two united. (Fig. 23.)

Under this name I have included *rufipennis, dichrous, spurcus, megatoma,* as I can see no characters by which they can be separated. The sparsely pubescent uniformly colored elytra, the broad prosternum and the structure of the male antennæ are diagnostic.

Occurs everywhere.

A. pellio Linn. Elongate, convex, black, clothed with short, semi-erect, brown hairs; head coarsely punctate, pubescence sparse, brown and erect, antennæ rufo-testaceous, club cinereous. Thorax coarsely punctate, base and angles clothed with white pubescence; scutellum pubescent. Elytra black, sparsely pubescent, a small smooth spot on either side of suture is clothed with dense white hairs. Body beneath black, coarsely punctate, pubescence yellow, semi-erect. Prosternum wide, moderately long; abdominal segments rufous, margined with black, pubescent. Length .21 inch; 5.5 mm. (Figs. 29, 30.)

Male. Antennal club with joints 9–10 very small—last joint very large, as long as all the remaining portion of the antennæ.

Female. Antennal club compact, joints 9–10 wide, together equaling the last segment.

Distinguished by the elytral spots, uniform color, and the structure of the prosternum and male antennal club.

Occurs in New England.

A. Hornii, n.sp. Elongate, convex, black, clothed with dense, cinereous, semi-erect pubescence. Elytra fulvous with a broad longitudinal black band, interrupted obliquely at basal third, of black; head coarsely punctate, pubescent, antennæ testaceous; thorax coarsely punctate, densely pubescent. Elytra coarsely punctate, fulvous with a basal spot and longitudinal band rufous; entirely clothed with dense, cinereous recumbent pubescence. Body beneath rufo-piceous, moderately coarsely punctate, clothed with short cinereous hairs, prosternum moderately long, wide. Mesosternum twice as wide as long, sulcate in front, very prominent. Abdominal segments black with short cinereous hairs. Legs testaceous. Length .14 inch; 3.5 mm. (Figs. 24, 25.)

Male. Antennal club elongate, with joints 9–10 very large, equal, together as long as all the preceding joints, 11 elongate almost equal to 9 and 10 united. (Fig. 18.)

Female. Antennal club elongate, joints 9–10–11 equal. (Fig. 19.)

This species is easily separated from the rest, by the markings, and dense cinereous pubescence of the elytra and by the structure of the male antennal club. The mesosternum is long, less deeply sulcate and more prominent than in the other species.

It was recognized by Crotch as a new form and labeled in the collections with the above name, although no description has ever been published.

A. byturodes Cr. of the Check List is the female of this species. Occurs in the Pacific States.

A. perplexus n.sp. Elongate, convex, black, clothed with short, black, semi-erect pubescence. Elytra with broad sinuous basal and a few spots at middle and apex, of whitish pubescence. Head coarsely punctate, pubescence black and cinereous. Antennæ rufous. Thorax densely and coarsely punctate, disc sparsely, sides and base more densely clothed with long semi-erect yellow pubescence. Elytra black, with a piceous sinuous sub-basal band which bears whitish-yellow hairs. Body beneath black, coarsely punctate, pubescence short, semi-erect, yellowish-white. Prosternum wide, moderately long, abdominal segments black, finely punctate, pubescent, legs rufous. Length .16 inch; 4 mm.

Male. Antennal club with joints 9–10 equal; 11 slightly longer not equal to both the preceding united.

Female. Antennal club with the last joint equal to two preceding united.

This species is entirely different in appearance and in the structure of the male antennal club from all others in our fauna except *varicolor*, from

which it can be easily distinguished by the narrow short prosternum and broad confluent piceous spots on the elytra of the latter.

Occurs in Nevada.

A. varicolor, n. sp. Elongate, convex, black, covered with whitish-yellow, semi-erect pubescence. Head and thorax coarsely punctate, pubescent. Antennæ rufous. Scutellum pubescent. Elytra black, clothed with black, semi-erect pubescence, marked by three irregular transverse confluent rufous spots, with three sinous transverse bands of white semi-erect pubescence. Body beneath black, punctate, covered with short, cinereous hairs. Prosternum very short and narrow. Legs rufo-testaceous. Length .16 inch; 4 mm. (Figs. 20, 21, 27, 28.)

Male. Antennal club not quite twice as long as all the preceding portion, with joints 9–11 very large; last joint only slightly longer.

Female. Antennal club small, equal to all the preceding joints united, last joint almost equal to the two others together.

The distinguishing characters of this species are the narrow prosternum; structure of male antennal club; the elytra, black and piceous, bearing three distinct white fasciæ.

Occurs in the Pacific States.

DEARTHRUS Lec.

Head as wide as anterior border of thorax. Eyes round, large, very prominent, entire. Antennæ 9-jointed, terminated by a 3-jointed club (fig. 33). Thorax not twice as wide as long, slightly bisinuate at base. Elytra elongate, sides nearly parallel. Prosternum one-third as long as wide, tip sub-acute, not produced beyond anterior coxæ. No true antennal fossæ. Mesosternum narrowly divided. Mesocoxæ not widely separated (fig. 32). Metasternum short, side pieces wide. Posterior coxæ not reaching the sides of body. Coxal plates short and wide, covering more than basal half of femora. Legs slender, first four joints of tarsi subequal, last joint much longer, hardly equal to all the others taken together.

This genus, founded upon one species, has been merged into *Attagenus*, from which, however, it is undoubtedly distinct. The 9-jointed antennæ, the peculiar prosternum, the narrowly divided mesosternum, the short and wide posterior coxal plates like those of *Trogoderma* and allied genera, and finally, the entire facies of the insect, are characters too important to be overlooked or underestimated.

D. longulus Lec. Elongate, compressed, black, clothed with sparse yellow semi-erect pubescence. Head black, coarsely punctate, sparsely pubescent. Thorax coarsely punctate, sparsely pubescent. Elytra black or piceous, coarsely punctate, sparsely pubescent. Body beneath rufous, moderately coarsely punctate, clothed with sparse, cinereous pubescence. Abdominal segments rufous, margined with rufo-testaceous, punctate, pubescent. Legs rufous. (Fig. 31.)

Length .1 inch; 2.5 mm.

Male. Antennæ of nine joints, first very large, sub-oval; second somewhat smaller; 3–6 small; 7–9 forming the club equal to all the preceding united, of which the first is very small; the second wider and longer; the last twice as wide as the second and almost three times as long as the two united, obtusely pointed at tip.

Female. Club of antennæ a little more than half as long as the preceding joints taken together; last joint as wide as, and little longer than the second; nearly truncate at tip.

Occurs in the Atlantic district.

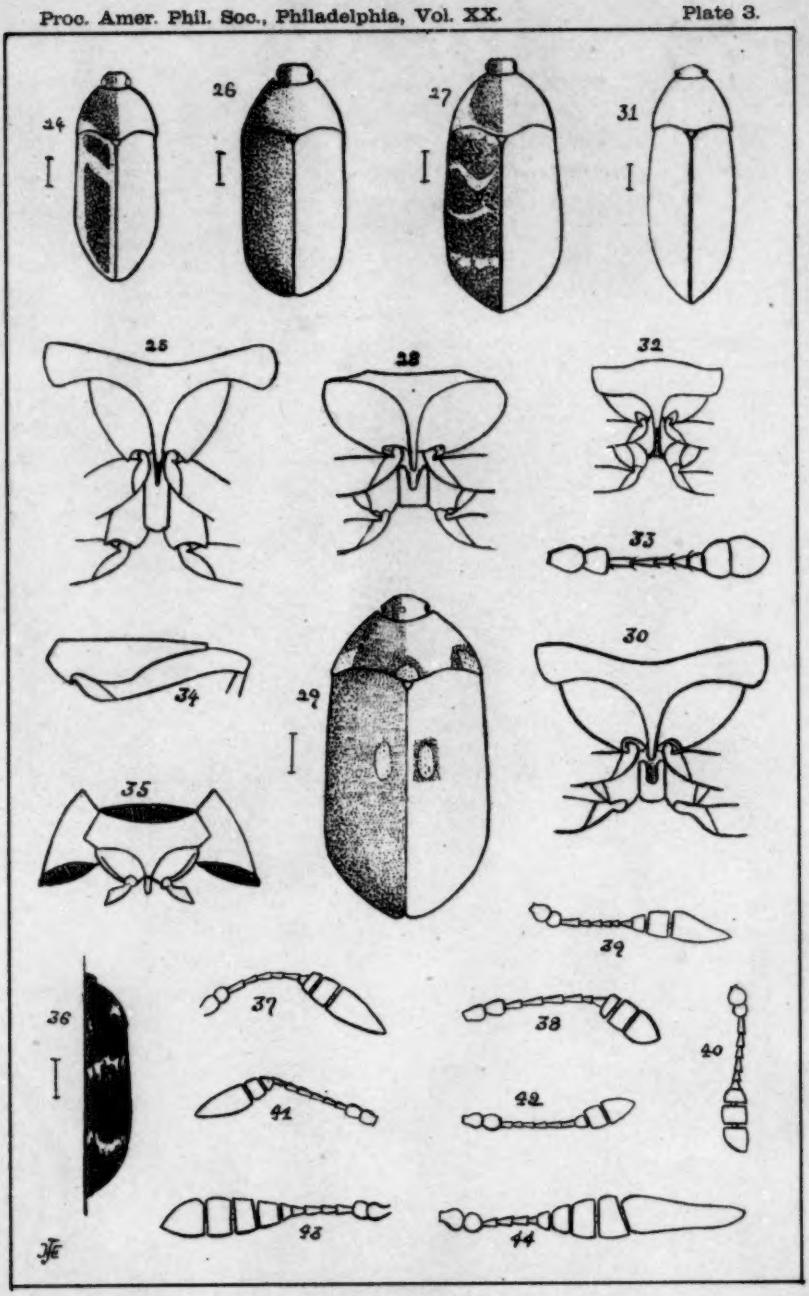
PERIMEGATOMA Horn.

Form elongated, only moderately convex, body dark in color. Head moderately wide, front flat, epistoma moderately short; a distinct ocellus. Antennæ 11-jointed, club 3-jointed, except in *Belfragi*, where it is 5-jointed. Eyes large, round, prominent, and entire. Thorax twice as wide at base as at apex, and half as long as the greatest width, very convex and prominent in front, with a transverse depression across the base, which is slightly bisinuate. Sides arcuate, hind angles prominent, except in *Belfragi*, where they are somewhat retracted. Scutellum small, but distinct. Elytra long, sides nearly parallel, apices not separately rounded. Prosternum only moderately broad, and very long, lobed in front, covering all the mouth parts, except the labrum, produced behind into a short tip received into the mesosternum, which is narrow and deeply emarginate. No antennal fossæ, spaces between prosternum and lateral margins slightly concave (Fig. 35), metasternum short, side pieces wide. Legs stout. Posterior coxæ do not attain the sides; coxal plate short, moderately wide (Fig. 34); first joint of tarsus long, 2–3–4 successively shorter, 5 as long as first.

This genus was established for several species, occuring from Lake Superior to Texas, California and Sitka, which agree with *Megatoma* in all the characters except in the antennal fossæ, which are absent in this genus. The ornamentation, by the pubescence of the surface, resembles somewhat that of *Megatoma*, there being two transverse, undulating, cinereous bands, the one at the basal third, the other at the apical fourth.

The following is the arrangement of the species, proposed by Dr. Horn (Trans. Am. Ent. Soc. 1875, p. 135):

Antennal club 3-jointed.
  First joint of club in both sexes, very little smaller than the second joint.
    Pubescence unicolored, grayish-white (.16 inch)..... **cylindricum.**
    Pubescence bicolored (.20 inch)..... **variegatum.**
  First joint of club extremely short.
    Pubescence bicolored (.14)..... **falsum.**
Antennal club 5-jointed.
    Pubescence bicolored..... **Belfragi.**



DERMESTIDÆ.

P. cylindricum Kby. Oblong, oval, piceous, shining, sparsely clothed with moderately short, semi-erect, easily removed, cinereous pubescence. Elytra uniformly piceous or marked by two transverse rufous bands. Head coarsely and densely punctate, pubescence sparse. Antennæ rufous. Thorax very densely and coarsely punctate, moderately densely pubescent, especially at sides. Elytra less densely and coarsely punctate, either black and uniformly pubescent or marked by two piceous bands at apical and basal third, to which the pubescence is more closely adherent. Body beneath piceous, coarsely punctate, moderately densely pubescent. Legs piceous. Length .13–.16 inch ; 3.2–4 mm.

Male. First and second joints of antennæ large, sub-equal, 3–8 very small, 9–11 forming a club which is longer than all the preceding joints together, the first nearly as large as the second, and the last longer than the other two together, and pointed at tip. (Fig. 37.)

Female. Club of antennæ only half as long as the preceding joints together, last joint not much larger than second, obtusely pointed at tip. (Fig. 38.)

Occurs from Hudson Bay Territory to California.

Certain specimens from California, in Dr. LeConte's collections, differ somewhat in the ornamentation of the elytra. Dr. Horn describes them as follows :

Specimen a. Uniformly piceous, pubescence normal, slightly denser at the sides of the thorax *(angularis* Mann).

Specimen b. Similar to *a*, but with the pubescence adhering more closely, and forming a very indistinct sinuous band at basal and apical third.

Specimen c. Elytra with sinuous, transverse, rufo-piceous bands at apical and basal third, to which the pubescence is very closely adherent, causing the elytra to be conspicuously marked.

This species is easily recognized by the uniform color of the pubescence and by the antennal club.

P. falsum Horn. Form, color, and ornamentation as in *cylindricum, variety c.* The pubescence of the elytra is bicolored, composed of pale-brownish and grayish-white hairs intermixed, the former forming a narrow, transverse band in front of the rufous bands of the elytra. Length .14 inch ; 3½ mm.

Male. Club of antennæ slightly longer than all the preceding joints together, first joint extremely short, but nearly as wide as the second, terminal joint more than twice as long as the two preceding together, and pointed at tip. (Fig. 41.)

Female. Club of antennæ not longer than the preceding joints taken together, first joint much shorter than the second, terminal joint slightly longer than the first two united, and but little longer than wide, oval at tip. (Fig. 42.)

Occurs in California, and is to be known by the short first joint of the antennal club.

P. variegatum Horn. Oblong-oval, piceous or piceo-rufous. Elytra with two sinuous transverse bands of rufous, with dense white pubescence. Head and thorax densely punctured, covered with intermixed pale-brown and white hairs. Elytra oblong-oval, sides sub-parallel, surface less densely punctured than the thorax. Color piceous, with a sinuous rufous band at basal and another at apical third, rather densely covered with white pubescence, the remainder of the surface with intermixed pale-brown and whitish hairs. Body beneath densely punctured, sparsely covered with cinereous hairs. Antennæ rufous or pale brown. Length .20–22 inch; 5–5.5 mm. (Fig. 36.)

Male.—Club of antennæ not quite equal to the preceding joints united, first joint as large as second, terminal as long as the first and second together, and pointed at tip. (Fig. 39.)

Female. Club of antennæ not longer than preceding joints together, first two joints nearly equal, and the terminal shorter than the other two united, oval and slightly obliquely truncate on the inner side. (Fig. 40.)

Occurs in California and Oregon. This species is larger and broader than the two just considered. It may be recognized by the bicolored pubescence and the structure of the antennal club.

P. Belfragi Lec. Structure, color and ornamentation similar to the preceding species, but the form is decidedly more elongate. Length .22 inch; 5.5 mm.

Male. Club of antennæ of five joints, twice as long as all the preceding joints united, first and second joints moderately wide, but short, subequal, third and fourth much wider, and twice as long, terminal as long as the four preceding together, and obtusely pointed at tip. (Fig. 43.)

Female. Club of antennæ of five joints, about equal to the preceding joints united; terminal joint hardly equaling third and fourth, almost globular. (Fig. 44.)

Occurs in Texas.

ACOLPUS, n. g.

Head as wide as front margin of thorax. Frontal ocellus distinct. Eyes large, prominent, round and entire, moderately coarsely granulated, mouth parts free, antennæ 11-jointed, thorax about twice as wide at base as long, apex only one fourth as wide as base, sides arcuate, lateral margins somewhat flattened, hind angles prominent, base bisinuate. Scutellum small, nearly covered by the thorax; elytra about twice as long as wide, sides subparallel, apices slightly separately rounded; no antennal fossæ; spaces between prosternum and lateral margin concave, coarsely punctate; prosternum broad, moderately long, produced posteriorly into an acute long tip, completely dividing the mesosternum, which is wide. Mesocoxæ therefore widely separated. Mesosternum short, side pieces

wide; hind coxæ moderately long, narrow, coxal plates only attaining side pieces. Legs stout, reaching sides of body; first joint of tarsus long, second shorter, third and fourth still smaller, the fifth equals the first.

This genus differs from *Trogoderma* by the absence of the antennal fossæ. There is but one species.

A. primus, n. sp. Elongate, moderately convex, black, clothed with very sparse, semi-erect, moderately long, cinereous pubescence. Elytra piceous, with a moderately broad transverse sinuous band on the basal third yellow, antennæ, abdomen and legs, piceous. Head densely and very coarsely punctate, antennæ 11-jointed; joints 1–2 large; 3–5 much smaller; 6–11 large and wide, forming an elongate serrated club. Thorax very densely and coarsely punctate, pubescent at sides. Elytra coarsely, much less densely punctate; a transverse depression across the base, piceous except a transverse sinuous yellow band at the junction of the basal and middle thirds, which is moderately broad and directed slightly forward, and somewhat more densely covered with lighter hair. Body beneath rufous, very coarsely punctate, pubescence shorter, more dense and recumbent. Length .08 inch; 2mm. (Fig. 45.)

Two specimens from Texas in Dr. LeConte's cabinet, from Mr. Belfrage.

The single light band on the elytra will serve as an additional character to separate this species from any of our known *Trogoderma*.

TROGODERMA Latr.

Oblong, convex, dark, elytra marked with sinuous rufous bands, bearing light pubescence. Head small, a distinct ocellus, front flat, clypeus short. Eyes prominent, moderately coarsely granulated, round, entire in *simplex*, *sternale* and *ornatum*, emarginate in front in *inclusum*. Thorax very convex, twice as wide at base as long, base three times as wide as apex, bisinuated, slightly produced sub-acutely in the median line, sides arcuate, hind angles moderately prominent. The antennæ are 11-jointed, terminated by a club which is 6-jointed and strongly serrate in the males of *sternale* and *ornatum*, 7-jointed, not pectinate in the males of *inclusum*, and 5-jointed in the females of *simplex*, and 4-jointed in the females of the other species. Scutellum moderately large, uncovered. Elytra with sides sub-parallel, apices separately rounded.

Antennal fossa occupying the entire space between the prosternum and lateral margin of thorax, except in *simplex*, where they are limited to the anterior part of the prosternal suture. Prosternum moderately broad and long, not lobed in front, produced behind into a long tip, which is broad, entirely dividing the mesosternum in *simplex*, *ornatum* and *inclusum*, acute in *sternale*, the mesosternum being only deeply emarginated. Mesocoxæ very widely separated. Posterior coxal plates moderately long and wide, not reaching the sides. Legs stout, femora grooved beneath to receive

the tibiæ; first joint of tarsi long, second, third and fourth successively shorter, together equaling the fifth.

The elytra of all the species, in our fauna at least, are fasciate. The anatomical characters by which to recognize this genus are: the distinct antennal fossæ, characteristic antennæ, prosternum not lobed in front, the broad, deeply emarginate or entirely divided mesosternum, and the moderately wide and long posterior coxal plate.

Our species may be arranged as follows:

Eyes entire.
  Antennal fossa near prosternal suture.... ..... **simplex.**
  Antennal fossa sub-marginal.
    Prosternal tip broad.
      Mesosternum broadly divided..... **ornatum.**
    Prosternal tip narrow.
      Mesosternum deeply emarginate..... **sternale.**
Eyes emarginate in front..... **inclusum.**

T. simplex, n. sp. Oblong, black, clothed with black semi-erect pubescence. Elytra black, with three sinuous bands and apical spot rufous with white pubescence. Head coarsely punctate, front covered with coarse yellow hair. Eyes entire, moderately prominent. Antennæ piceo-testaceous, joints 1 and 2 rufous. Thorax coarsely, not very densely, punctate, with whitish-yellow pubescence at sides and base, disc less pubescent. Scutellum pubescent. Elytra coarsely punctate, black, with three irregular bands of red, bearing semi-erect whitish pubescence. Body beneath black, coarsely punctured, clothed with short recumbent cinereous pubescence. Antennal fossa limited to a small space near prosternal suture. Prosternum long, moderately broad, tip prolonged, completely dividing the mesosternum. Abdominal segments black, margined with rufous, clothed with cinereous pubescence. Legs piceous, tibiæ and tarsi rufous. Length .20 inch; 5 mm. (Figs. 51, 52.)

Male unknown.

Female. Antennæ with joints 1 and 2 large, almost equal, 3–6 small, globular, 7–11 forming the club, which is fusiform.

The distinguishing characters of this species are the completely divided mesosternum, the entire eyes, and antennal fossæ limited to the prosternal sutures. It is of larger form than any of our known species. Found in the Western States.

T. ornatum Say. Oval, black, clothed with semi-erect, black pubescence. Elytra with three irregular confluent bands and apical and basal spots of gray pubescence. Head with front densely and coarsely punctate, clothed with erect black pubescence, eyes entire, moderately prominent. Antennæ testaceous. Thorax moderately sparsely punctate. Scutellum pubescent. Elytra coarsely, moderately sparsely punctate, black, clothed with black pubescence and with three irregular bands of red, bearing gray pubescence.

Body beneath black, clothed with cinereous pubescence, coarsely punctate. Antennal fossæ deep and large. Prosternum long and moderately broad, tip broad, sub-carinate. Mesosternum completely and broadly divided to receive prosternum. Abdominal segments black or rufous, coarsely punctate and pubescent. Legs rufous. Length .08–.20 inch; 2.5 mm. (Figs. 46, 47, 48.)

Male. Antennæ with joints 1–2 large and equal, globular, 3–5 small and globular, 6–11 strongly pectinate, forming the club.

Female. Antennæ with joints 1 and 2 almost equal, large, globular, 3–7 small, globular, 8–11 forming the club.

This species may be separated by its entire eyes, the character of the antennæ, the large antennal fossæ, the broad tip of the prosternum and the widely divided mesosternum. It is of moderate size.

Occurs everywhere.

T. sternale, n. sp. Oblong, black, clothed with sparse, black, semi-erect pubescence. Elytra black, with three irregular confluent bands and apical and basal spots of red, bearing whitish pubescence. Head coarsely punctate, sparsely pubescent. Eyes entire, moderately prominent. Antennæ rufo-testaceous. Thorax coarsely punctate, sides and base bearing whitish pubescence. Elytra black, with three variable rufo-testaceous bands, bearing white or gray pubescence, the rest sparsely clothed with black hairs. Body beneath piceous, coarsely punctate, with cinereous pubescence. Antennal fossa moderately deep, occupying all the space between prosternum and lateral margins. Prosternum short, moderately wide, tip convex and acute. Mesosternum deeply incised but not entirely divided. Abdominal segments piceous (variable to rufous), apical margins testaceous. Legs rufous. Length .08–.16 inch; 2–4 mm. (Fig. 50.)

Male. Antennæ with joints 1 and 2 large, 3–5 small and equal, 6–11 forming a deeply pectinate club; joints 10 and 11 are usually connate.

Female. Antennæ with joints 1 and 2 large, 4–7 small, 8–11 forming the club.

The distinctive characters of this species are the entire eyes; pectinate antennæ; large antennal fossæ; acute tip of prosternum and the mesosternum only deeply incised. It is the smallest form in the genus.

Occurs in California, New Mexico, Arizona, Texas, &c.

T. inclusum Lec. Oval, somewhat oblong, black, clothed with moderately long semi-erect black pubescence. Elytra with four sinuous confluent bands of red, bearing whitish pubescence. Head coarsely and densely punctured, quite sparsely pubescent. Eyes deeply emarginate in front, not very prominent. Antennæ testaceous. Thorax finely punctate, moderately sparsely pubescent. Elytra black, with four irregular bands of red, bearing grayish pubescence, the rest with sparse black pubescence, coarsely punctate. Body beneath piceous, coarsely punctate, with cinereous recumbent pubescence. Antennal fossa deep, occupying nearly all

the space between the front and lateral margins. Prosternum short, moderately wide, tip wide, convex, not carinate. Abdominal segments rufous, apical margins paler, pubescent. Legs rufo-testaceous. Length .08–.16 inch; 2–4 mm. (Fig. 53.)

Male. Antennal joints 1 and 2 large, 3–4 very small, 5–11 forming the club, which is not deeply pectinate.

Female. Antennal joints 1 and 2 large, 3–7 small, 8–11 forming the club.

This well known species possesses well marked characters by which it can be at once separated from the preceding forms. The emarginate eyes and non-pectinate antennæ united with large antennal fossæ, broad prosternal tip and completely divided mesosternum are conclusive. *T. tarsale* Mels. and *T. pallipes* Zieg. are identical with this species.

Occurs in Pennsylvania, Massachusetts and South Carolina.

CRYPTORHOPALUM Guèr.

Head moderately large, front wide, with a prominent ocellus, the epistoma short and on the same plane with the front, eyes prominent, round, moderately coarsely granulated, entire. The antennæ are 11-jointed, terminated by a 2-jointed club, which is twice as long in the males as in the females, the joints being equal in *hemorrhoidale*, the terminal joint much shorter than the preceding in all the other species. The thorax at base is twice as wide as long, apex one half the width of the base; the latter bisinuate, quite strong, lobed behind on the middle line, lobe truncate, partially overlapping the scutellum; the sides are arcuate, somewhat dilated over the antennal fossæ in the males of all the species, very markedly so in *ruficorne;* hind angles acute and prominent except in the male of *ruficorne*, where they are retracted. Scutellum distinct, triangular. Elytra widest at base, sides oval, apices separately rounded. Antennal fossæ distinct; the mouth parts, except the labrum, are covered by the prosternum which is not lobed in front, but is wide, moderately long, the tip broadly produced, widely dividing the mesosternum and consequently causing the mesocoxæ to be widely separated. Metasternum short, side pieces wide. Hind coxal plates moderately long, wide, reaching the epimera of metathorax. Legs stout, femora grooved beneath for tibiæ, first and last joint of tarsi long, nearly equaling the small intermediate ones united.

The species of this genus are small, black or piceous, and moderately coarsely punctate, the elytra are sparsely pubescent except in *balteatum*, where the grayish hairs are arranged in fasciate form. The anatomical characters by which this genus is separated from the others, are the wide, short, flat front; the 2-jointed club of the antennæ; the submarginal antennal fossæ; the prosternum covering all the mouth parts except the labrum; its broad tip dividing widely the broad mesosternum; and the wide, moderately long, posterior coxal plates.

The species can be tabulated as follows :—

Elytra with two sinuous transverse bands, humeral ring, and apical spot of yellowish white pubescence..... **balteatum.**
Elytra sparsely and uniformly pubescent.
Posterior third distinctly lighter in color than the remainder. Both joints of the antennal club subequal; metasternum finely and sparsely punctate.. **hemorrhoidale.**
Apex only distinctly lighter than remainder.
Last joint of antennal club much smaller than preceding. Metasternum coarsely and densely punctate, **apicale.**
Elytra uniform in color. Last joint of antennal club smaller than preceding.
Thorax finely and densely punctate; sides nearly arcuate and hind angles acute in the male..... **triste.**
Thorax almost smooth; sides greatly dilated and hind angles retracted in the male..... **ruficorne.**

C. balteatum Lec. Oval, convex, piceous or fuscous, clothed with moderately long, yellowish, semi-erect pubescence. Elytra marked by two transverse sinuous bands, a humeral ring, and apical spot of longer whitish pubescence. Head coarsely punctate. Antennæ fuscous, terminated by a large 2-jointed club. Thorax convex, hind angles acute, moderately finely punctate, pubescence more dense at sides and base. Scutellum small, naked. Elytra coarsely punctate, piceous, sparsely clothed with semi-erect, yellow and black pubescence, with humeral ring, two transverse bands, and apical spot of dense whitish-yellow hairs. Body beneath black or piceous, coarsely punctate, covered with fine, long, semi-erect, yellowish-white pubescence. Metasternum moderately finely punctate. Abdomen fuscous, coarsely punctate, densely pubescent. Legs rufous.

Male. I have not been able to see any males of this species.

Female. Antennal club elongate, made up of two joints, nearly equal, about as wide as long, together equaling all the preceding joints. The club is received into a fossa which occupies only the anterior half of the space between the prosternum and lateral margin, is almost circular, and appears to lie transversely. Length .10 inch; 2.5 mm. (Fig. 44.)

The distinguishing characters of this species are the coarsely punctate, piceous, fasciate elytra, and the structure of the antennal club.

The banded elytra give the insect the appearance of a *Trogoderma*, but the generic characters, already given, serve to separate this species with certainty.

Occurs in the Pacific States.

C. hemorrhoidale Lec. Elongate-oval, moderately convex, reddish-brown, clothed with moderately long, yellow, semi-erect pubescence. Elytra reddish-brown, posterior third lighter. Head black, very coarsely and densely punctate, sparsely pubescent. Antennæ light brown. Thorax

convex, moderately finely punctate, pubescence long and yellow. Scutellum naked and rough. Elytra black as far as the posterior third, which is piceous or rufous, very sparsely pubescent, coarsely and moderately densely punctate. Body beneath black, coarsely, except the metasternum, which is finely punctate; pubescence long and yellow. Legs with thighs rufous, tibiæ and tarsi lighter. Length .09 inch; 2.1 mm.

Male. Antennal club very large, composed of two sub-equal joints, almost disc-shaped, and twice as long as the preceding segments united. (Fig. 45.)

Female. Antennal club of two sub-equal joints, together only as long as all the other joints united. (Fig. 46.)

The important characters which enable us to separate this species are, the constant light color of the posterior third of the elytra, the oval antennal club of two sub-equal joints, and the finely punctate metasternum.

Occurs in the Southern and Western States.

C. apicale Mann. Elongate, convex, black, sparsely clothed with moderately long, yellowish, semi-erect pubescence. Head coarsely punctate, sparsely pubescent. Antennæ light brown. Thorax with hind angles acute, black, finely and densely punctate, pubescence sparse. Scutellum small, scabrous, naked. Elytra black, apex rufous, coarsely punctate, pubescence sparse, yellow and black; apex usually clothed with dense yellow hairs. Body beneath black, moderately coarsely punctate, sparsely pubescent. Metasternum very coarsely punctured. Abdomen black or piceous. Legs rufous, tibiæ, etc., lighter. Length .11 inch; 2.3 mm.

Male. Antennal club elongate, of two joints, the last of which is half as long as the preceding, together twice as long as all the others united. Club received into a fossa which extends almost to the posterior angle of lateral space. (Fig. 57.)

Female. Antennal club as in male, but only half as long; the fossa occupies only the anterior half of the lateral space. (Figs. 58, 59.)

The prominent characters of this species, are found in the apical color of the elytra, the coarse puncturing of the metasternum and the elongate antennal club, composed of two unequal joints.

Occurs in California.

C. ruficorne Lec. Sub-oval, convex, black or piceous, clothed with yellowish semi-erect pubescence. Head coarsely punctate, pubescence sparse and yellow. Antennæ very light, almost testaceous. Thorax convex; in the male the lateral margins are strongly dilated over the antennal fossæ and the hind angles are retracted, very finely and sparsely punctured, pubescent at sides. Scutellum naked, black. Elytra piceous, coarsely punctured, clothed with sparse yellow and black hairs. Body beneath almost black, coarsely punctured, sparsely pubescent. Metasternum very coarsely punctate. Legs rufous. Length .08 inch; 2 mm. (Fig. 61.)

Male. Antennal club very broad—in other respects like the preceding species.

Female. Antennal club like the preceding species.

This form may be easily distinguished by the plain piceous elytra, the almost smooth thorax, which in the male has the margin dilated and convex where it forms a roof for the antennal fossa, and the hind angles retracted. The male club is very light in color and extremely broad.

Occurs in California.

C. triste Lec. Elongate-oval, black or piceous, convex, clothed with sparse, yellowish-red, semi-erect pubescence.

Head coarsely punctate, pubescence sparse and yellow. Antennæ light, last joint rufous or black. Thorax convex, hind angles acute in both sexes, finely but very densely punctured, sparsely pubescent at sides. Scutellum black, naked. Elytra entirely black, moderately coarsely punctate, pubescence very sparse, yellowish-red. Body beneath black, covered with sparse, fine, yellow, semi-erect, hairs. Metasternum very coarsely punctate. Legs entirely rufous. Length .08 inch; 2 mm. (Fig. 60.)

Male. Antennal club as in preceding species but more elongate and darker.

Female. Antennal club as in *ruficorne*, darker.

The distinguishing characters are, the plain dark colored elytra, the finely but very densely punctured thorax, and the elongate antennal club of two unequal joints.

I can see no valid difference between this species and *nigricorne* Lec. and *picicorne* Lec; *fusculum* Lec. appears to be only a smaller variety which is more pubescent.

Occurs everywhere, in the Atlantic region.

AXINOCERUS, n. g.

Head large, front convex between the eyes, clypeus forming an angle with the front, retracted (Fig. 64). Eyes large, globular, finely granulated, entire, a distinct ocellus. Antennæ inserted under the angle formed by the meeting of the clypeus and front, of eleven joints, bearing an enormous securiform club of one joint. (Fig. 63.) Thorax about twice as wide at base, as long; apex less than half the width of the base, margined; sides arcuate, slightly flattened, margined; posterior angles acute, base slightly bisinuate, broadly lobed at middle, lobe truncate. Scutellum small. Elytra with humeral angles not prominent, sides arcuate, apices separately rounded. Antennal fossa large, somewhat triangular, occupying the entire space between prosternum and lateral margin. Mouth parts, except labrum, covered by the prosternum, which is broad, moderately long, the anterior margin somewhat deflexed, the tip broadly produced posteriorly, dividing the mesosternum. Mesocoxæ widely sepa-

rated. Metasternum broadly truncate in front. Hind coxæ, coxal plates and legs as in *Cryptorhopalum*.

The creation of this genus is made necessary by the discovery of a new species which cannot be relegated to any of the existing genera. It is closely allied to *Cryptorhopalum* from which it differs only by having a long, retracted clypeus and an antennal club unlike anything heretofore described as occurring in this family. The general form, moreover, is more broadly oval than in the preceding genus.

A. americanus, n. sp. Broadly oval, convex, black, shining, clothed with moderately long, semi-erect, brown pubescence. Elytra uniformly black. Abdomen, legs, and antennæ rufous. Head coarsely not densely punctate. Antennæ of eleven joints, of which 1 and 2 are moderately large, globular, sub-equal. 3–10 small, increasing in size as they recede from the head, to be joined to the basal portion of the upper edge of the large terminal joint, which is flat, broad at base, pointed at apex, three times as long as wide, a little more than twice as long as all the preceding joints taken together. Thorax sparsely and finely punctate at middle, more densely and coarsely at sides. Scutellum smooth and naked. Elytra rather coarsely, not densely punctate, black, side margins near apex rufous. Body beneath black, coarsely and moderately densely punctate, very sparsely pubescent. Length .08 inch; 2 mm. (Fig. 62.)

One specimen from Lavaca county, Texas, in Dr. LeConte's collection, collected by Mr. Schwarz.

ANTHRENUS Geof.

Ovate, convex, dark, covered with scales which are large and triangular in *scrophulariæ*, smaller in *museorum* and *claviger*, and very long and narrow in *varius*. Head small, a distinct ocellus, epistoma moderately long and flat, mouth parts entirely protected by the prosternum. Eyes moderately large, prominent, emarginate in *scrophulariæ*, entire in the rest of our species. Antennæ short, 11-jointed in *scrophulariæ* and *varius*, terminated by a 3-jointed club; 8-jointed in *museorum*, bearing a 2-jointed club, and 5-jointed in *claviger*, with a large club of one joint. Thorax very convex at base, more than twice as wide as long; base three or four times as wide as apex, bisinuate, lobed behind in the median line; lobe acute, covering almost the entire scutellum; lateral margins slightly expanded, arcuate; hind angles prominent. Elytra ovate, apices slightly separately rounded. Antennal fossa dividing the anterior part of the lateral margin of thorax. (Fig. 65.) Prosternum short and wide, lobed in front, covering all the mouth parts except the labrum, produced behind into a broad tip, which does not reach much beyond the anterior coxæ. Mesosternum very wide, completely and broadly divided. Mesocoxæ very widely separated. Metasternum short, side pieces wide. Posterior coxal plate moderately short, wide, but not reaching the sides. Femora stout, grooved beneath

for the tibiæ, which are quite slender. First four joints of tarsi small, sub-equal, terminal joint nearly as long as the four united.

This genus possesses very distinct characters by which it may be separated from all others, viz: The short, broad form; the thorax, so wide at base and narrow in front, with the antennal fossæ dividing its lateral margin; the mouth parts covered, except the labrum, by the prosternum; the widely separated mesocoxæ, and finally the clothing, consisting of large or small variegated scales.

The following table will enable us to recognize the species:

Antennæ 11-jointed; club 3-jointed.

Eyes emarginate; scales coarse, large, triangular, as wide as long. Antennal club oval..... **scrophulariæ.**

Eyes entire; scales fine, not triangular, three times as long as wide. Antennal club oblong..... **varius.**

Antennæ 8-jointed; club 2-jointed.

Eyes entire, scales small, triangular..... **museorum.**

Antennæ 5-jointed; club of a single very long joint.

Eyes entire, scales small, triangular..... **claviger.**

A. scrophulariæ Linn. Ovate, moderately convex, black, clothed with large, triangular, black, white, and orange-red scales. Elytra marked by a sutural longitudinal band and apical spot of orange-red scales and two transverse bands and basal spots of white. Head black, coarsely punctate, thickly covered with black scales, a few orange-red scales around the eyes and on clypeus. Eyes emarginate in front, not very prominent. Antennæ black, 11-jointed, terminated by a broadly oval 3-jointed club, which is as long as all the preceding joints united. Thorax black, coarsely punctate, disc covered with black, sides and base with white and orange scales. Scutellum hardly visible. Elytra black, mostly covered with black scales, but the suture is broadly orange with three equi-distant lateral projections of the same color, the first two of which join sinuous white bands; the posterior is obscurely connected with an apical orange spot; usually a distinct basal white spot. Body beneath black, covered with white and orange scales. First abdominal segment with two naked hollows, on each side of base, to receive the posterior femora, last four with lateral black spots; terminal segment with a large median quadrilateral black space. Legs black or rufous, femora clothed sparsely with white and yellow scales. Length .09–.14 inch; 2.2–3.5 mm. (Figs. 66, 69.)

A common and widely distributed species, to be recognized by the emarginate eyes, large scales, and broadly oval antennal club. The ornamentation varies greatly in color and arrangement. The entire color of the upper surface may be altered, the orange in the sutural band may be replaced by white, and the transverse bands may become indistinct and small, or again large and confluent.

Two varieties dependent on these changes are to be found in our fauna.

Variety **flavipes** Lec. In this, yellow scales seem to have replaced the black, on the head, on the disc of the thorax, between the sinuous bands on the elytra, arranged in spots on the sides of the abdomen and in a quadrilateral space on the last segment. Only a faint trace of white on each side of anterior part of suture. The white bands are larger than in a typical *scrophulariæ*, two large white spots near the apex, represent the posterior lateral prolongation of the sutural orange, and the apical spot. (Fig. 67.)

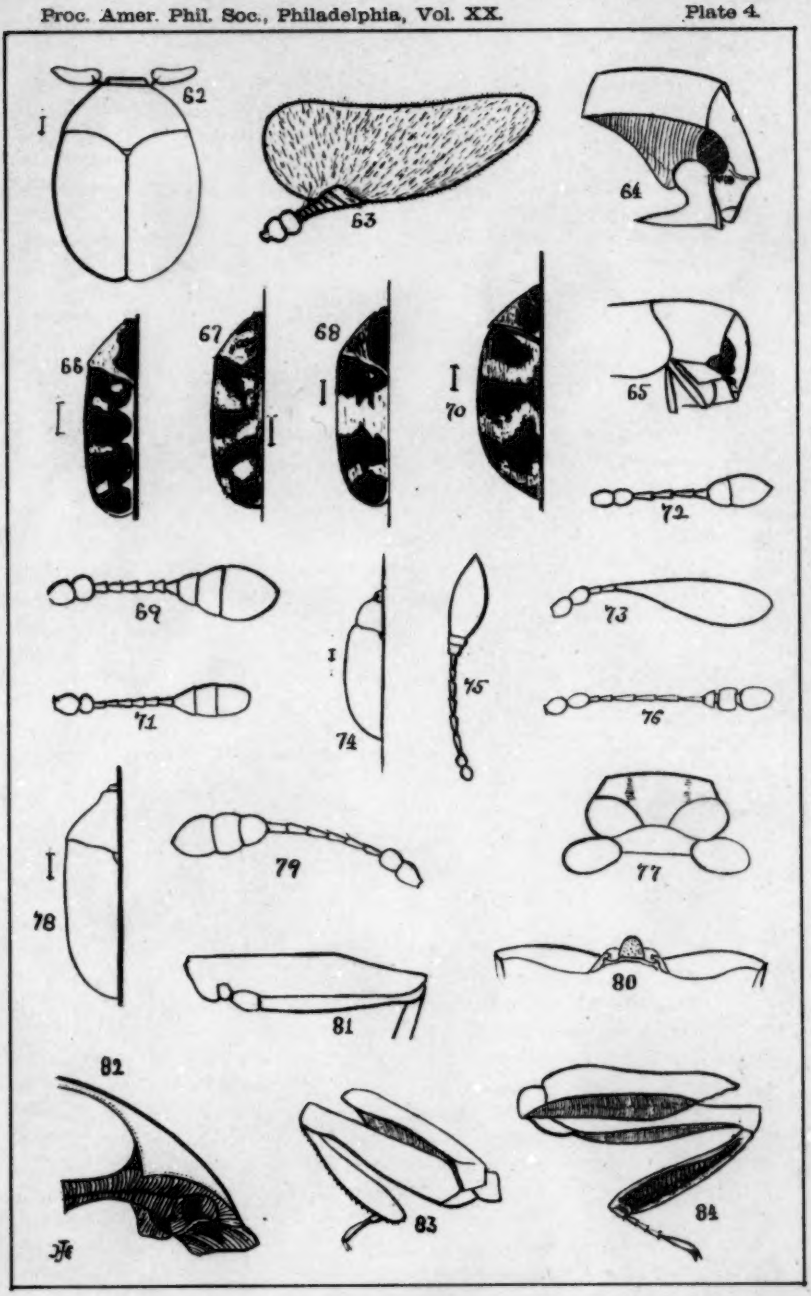
This variety I believe from the description given by Reitter to be the variety *albidus* of Brullé, but I have not had the opportunity for comparison.

Variety **thoracicus** Mels. The scales on the upper surface are black as in *scrophulariæ*, the orange suture may be present or replaced by white ; the first and second transverse bands are large, confluent at the sides only, or throughout their entire extent, forming a very wide sub-basal band. (Fig. 58.)

A. varius Fabr. Ovate convex, black, clothed with yellow, white, and black, fine, long scales. Elytra marked by a larger humeral ring, a transverse sinuous band, and an apical spot of mixed yellow and white scales. Head coarsely punctate, covered with fine yellow scales. Eyes quite prominent, entire ; antennæ black or rufous, 11-jointed, first and second joints large, globular, sub-equal ; 3–8 small, equal, compressed ; 9–11 form a club which equals the preceding part of the antennæ, the last joint decidedly larger than the other two. Thorax coarsely punctate, disc sparsely clothed with yellow, sides and lobe of base covered with white scales. Scutellum hardly discernible. Elytra black, coarsely punctate, covered with black scales and ornamented with a large basal ring, a transeverse median sinuous band, and an apical spot of mixed white and yellow. Body beneath black, clothed with fine, long, yellowish-gray scales, mixed at sides with yellow, first abdominal segment with a naked groove on each side of base to receive the posterior femora, last four marked with brownish-yellow spots at lateral margins ; only a faint spot of black in the middle of the last segment. Legs black, femora covered with scales. Length .07–.12 inch ; 1.7–3 mm. (Figs. 70, 71.)

The distinguishing characters of this species are the fine, narrow and long scales which clothe it ; the entire, prominent eyes, the 3-jointed elongate antennal club, and the almost uniform absence of a large black spot at the last ventral segment. The markings on the elytra vary considerably in different specimens, showing a series from a perfectly banded to an obscurely mottled form. The insects are widely distributed and in the larval stage are especially destructive to zoölogical collections.

A. museorum Linn. Oblong, brown, moderately convex, covered with black and yellowish-white, small, triangular scales. Elytra with black or brown scales sparsely mixed with white, three indefinite, irregular bands also white. Head covered with scales which are brown, around the eyes



DERMESTIDÆ.

whitish. Eyes very prominent, entire. Antennæ brown, 8-jointed; first joint is large, globular, 2–6 small, longer than wide, 7–8 forming the club, longer than wide, equal, together not making up quite one-half the entire antenna. Thorax covered with scales, brown at disc, yellow and white at the sides and base. Scutellum hardly seen. Elytra brown, covered, not densely, with brown and white scales, marked by three irregular indistinct sinuous bands and humeral spot of white. Body beneath brown, covered with small, triangular, cinereous scales, a row of black spots on each side of abdomen, no naked hollows on the first segment, and a faint median black spot on the last. Legs brown, femora clothed with whitish scales. Length .06–.10 inch; 1.5–2.5 mm. (Fig. 72.)

This species can be recognized by the entire eyes, the 8-jointed antennæ, and small triangular sparse scales.

A. claviger Er. Ovate, convex, black, clothed with black, moderately large, triangular scales. Elytra ornamented with three faint, sinuous bands and humeral spot of yellow scales. Head black, coarsely punctate, scales black and yellowish. Eyes prominent, entire. Antennæ 5-jointed; joints 1–2 large, globular, sub-equal, 3–4 very small and compressed, the last more than three times as long as the other joints united; rufous, last joint darker. Thorax coarsely punctate, scales black at middle, yellow at sides. Elytra black and piceous, very coarsely punctured, clothed with black scales and with three equally separated, indistinct, interrupted, sinuous bands, and humeral spot of small yellow scales. Body beneath black, covered with small sparse cinereous scales. Legs rufous. Length .07 inch; 3.7 mm. (Fig. 73.)

The smallest, darkest, and least conspicuously ornamented of any of our species. The distinguishing characters are the 5-jointed antennæ with its 1-jointed club, the entire eyes, the small sparse scales, and the almost uniform color of the elytra.

Occurs in Pennsylvania.

APSECTUS Lec.

The one species upon which this genus is established, is the smallest form found among our *Dermestidæ;* the head is wide, the epistoma short, the ocellus distinct, the mouth parts protected by the prosternum. Eyes very large, prominent, rounded, entire. Antennæ as long as the thorax, 11-jointed, terminated by a slender, elongated, 3-jointed club. Thorax twice as wide as long, sides flattened, lateral margins arcuate, hind angles prominent; base bisinuate, slightly lobed posteriorly at middle. Scutellum quite large. Elytra as wide as long, sides regularly oval, apical angles not separately rounded. Antennal fossæ not sharply defined, sub-marginal. Prosternum lobed in front, narrow, moderately long, produced behind between the anterior coxæ, separating them widely, but broadly truncate at tip, reaching the mesosternum which is short, three times as wide as long and rounded in front. Mesocoxæ very widely separated. Posterior

coxal plate very short, moderately wide, but not attaining the sides. Legs moderately stout, last joint of tarsus as long as the four preceding taken together.

This genus closely resembles *Trinodes*, but the latter has the prosternum prolonged sub-acutely behind, entirely dividing the mesosternum, and the antennal cavities are wanting.

A. hispidus Mels. Sub-oval, convex, black, covered with sparse, very long, erect, brown hairs. Elytra brown or black. Head sparsely pubescent. Antennæ 11-jointed, testaceous, club 3-jointed, darker. Thorax sparsely punctured and pubescent. Scutellum naked. Elytra black or rufous, coarsely, moderately sparsely punctate, pubescence sparse, very long. Body beneath light brown, pubescent. Abdomen coarsely punctate, pubescence more dense. Length .05 inch ; 1.5 mm. (Figs. 74, 77.)

Male. Antennæ terminated by a 3-jointed club, of which the joints 1–2 are small, 3 half as long as the entire antenna. (Fig. 75.)

Female. Antennæ bearing a 3-jointed club, the last joint of which is equal to the two preceding taken together. (Fig. 76.)

In addition to the anatomical characters already given, we may recognize the insect by the small size and long erect pubescence.

Occurs in the Middle and Southern States.

ORPHILUS Erichs.

Head with small but distinct ocellus. Eyes moderately prominent, moderately coarsely granulated, emarginate in front. Antennæ 11-jointed, bearing a 3-jointed club. Thorax very convex, nearly as long as wide at base, apex only one fourth as wide as the base, which is bisinuate, sides arcuate, lateral margins nearly straight, only the posterior half can be seen from above. Hind angles moderately prominent. Scutellum distinct. Sides of elytra nearly parallel, antennal cavities not well defined, confined to the anterior half of spaces between prosternum and side margins, which space is marked just behind middle, with a deep pit to receive the knee of the anterior leg, behind which is the usual transverse fossa for the middle leg. (Fig. 82.) Prosternum small, declivous, produced behind but not passing the anterior coxæ, which are very large and approximated. Mouth parts and prosternum covered by the anterior legs. Mesosternum large, as broad as long, rounded in front, widely separating the mesocoxæ. (Fig. 80.) Hind coxæ short and wide, reaching the sides of the body. Coxal plates also wide, covering the anterior portion of the femur for its entire length. (Fig. 81.) Femora very stout, attaining the sides, punctured, channeled beneath for the tibiæ, anterior tibiæ very broad and flat, with a groove on the anterior surface to receive the tarsus. (Figs. 83, 84.) The middle and posterior tibiæ are more slender. Tarsis moderately slender, last joint equaling the four preceding added together.

The characters upon which to rely for a proper appreciation of this genus are, the insignificant prosternum ; large, entire mesosternum ; the large

anterior legs protecting the mouth parts, the pits to receive the anterior knees, the character of hind coxal plates and the almost entire absence of pubescence.

O. glabratus Fabr. Ovate, black, moderately convex, shining, without pubescence. Elytra uniformly black. Head coarsely punctate. Antennæ rufous, 11-jointed, bearing a 3-jointed club which equals about one-half the preceding part of the organ. Joints 1–2 moderately large, 3–8 small, 9 twice as long as any of the preceding and as wide as long, equaling joint 10; the terminal joint is somewhat longer. Thorax coarsely punctate. Scutellum with a few fine punctures. Elytra entirely black, very coarsely punctured, with a transverse depression across the basal third and a faint vertical one on each side of the suture, on the apical half. Body beneath black, coarsely punctate, abdomen rufous, lighter at the edges of the segments. Legs rufous. Length .12 inch; 3 mm. (Figs. 79, 80.)

There is but one species in our fauna, but the punctures on the thorax vary considerably as to size and number, in the different specimens. When they are coarse and deep the insect is a true *glabratus;* when less coarse we may regard it as the variety *ater* Er., and when relatively fine as the variety *subnitidus* Lec. There are no characters of sufficient value to enable us to separate these forms into different species. The larger specimens, the second variety by the way, are from the Pacific, the smaller from the Middle States.

Synonymy and Bibliography.

DERMESTIDÆ.

SUB-FAMILY I; BYTURIDÆ.

BYTURUS.

Latr. Préc. car. Ins. 1796, p. 69.

unicolor Say. Journ. Acad. Phil., iii, p. 197.
americanus, Dej. Cat., 3d ed., p. 137.

grisescens Lec. New species, Col. 34, i, 1863.

SUB-FAMILY II; DERMESTIDÆ—(genuini.)

LeConte Synopsis, Proc. Acad. Phil., 1854, p. 106.

DERMESTES.

Linn. Syst. Nat. ii, 1767, p. 561.

marmoratus Say. Journ. Acad. Phil., iii, p. 197, Chevrol. Ann. Fr. 1863, p. 616.
var. Mannerheimi Lec., loc. cit., p. 107.

fasciatus Lec., loc. cit., p. 107.

murinus Linné, Faun. Suec., p. 144; Erich. Nat Ins., iii, p. 429.
caninus Germ., Ins., spec. nov., p. 84.
nubilus Say, Ins. of Louisana, 1832; Lec., loc. cit., p. 107.
dissector Kirby, Fauna. Bor. Am., iv, p. 115.
rattus Lec., loc. cit., p. 108.

talpinus Mann. Bull. Mosc., 1843, ii, p. 257.

sobrinus Lec., loc. cit., p. 108.
mucoreus Lec., loc. cit., p. 108.
pulcher Lec., loc. cit., p. 108.
lardarius Linn., Faun. Suec., p. 140.
var. signatus Lec., Trans. Amer. Ent. Soc., 1874, p. 50.
elongatus Lec., loc. cit., p. 109.
cadaverinus Fabr., Syst. Ent., p. 55; ibid. Ent. ii, 9, p. 7, t. 2, f. 9, a-b.
vulpinus Fab., Spec. Ins. i, p. 64.; Lec., loc. cit., p. 109.
lupinus Mann., Bull. Mosc., 1843, ii, p. 257.
maculatus DeGeer, Ins. iv, p. 223.

ATTAGENUS.

Latr. Gen. Crust. et Ins. ii, 1807, p. 32.

piceus Oliv., Ent. ii, 9, p. 10, t. 1, f. 4, a-b.
dichrous Lec., loc. cit., p. 110.
megatoma Fabr., Ent. Syst., Suppl., p. 71.
ruficpennis Lec., Proc. Acad. Phil., 1859, p. 71.
spurcus Lec., Synop., loc. cit., p. 109.
pellio Linné, Fauna. Suec., p. 141.
bipunctatus Deg., Ins. iv, p. 197.
Hornii, n. sp.
perplexus, n. sp.
varicolor, n. sp.

DEARTHRUS.

LeConte, Class. Col., N. Am., 1, 1861, p. 108.

longulus Lec., New Spec. Col., i, 1863, p. 73.

PERIMEGATOMA.

Horn, Trans. Amer. Ent. Soc., 1875, p. 135.

cylindricum Kby., Fauna Bor. Am., iv, p. 113, pl. 7, fig. 3; Horn, loc. cit., p. 136.
var. *angularis*, Mann. Bull. Mosc., 1853, iii, p. 216.
variegatum Horn, loc. cit., p. 136.
falsum Horn, loc. cit., p. 136.
Belfragei Lec., Trans. Amer. Ent. Soc., 1874, p. 49; Horn, loc. cit., p. 137.

ACOLPUS, n. g.

primus, n. sp.

TROGODERMA.

Latr., Regn. Anim. Ed. 2, iv, 1829, p. 511.

simplex, n. sp.
sternale, n. sp.

ornatum Say., Journ. Acad Phil. v, p. 185.
pusillum Lec., Synop. loc. cit., p. 111.
inclusum Lec., loc. cit., p. 110.
pallipes Ziegl., Proc. Acad. Phil. ii., p. 269.
tarsale Mels., Proc. Acad. Phil. ii, p. 116.

CRYPTORHOPALUM.

Guér., Ic. Regn. Anim. Ins., 1838, p. 67.

balteatum Lec., Synop. loc. cit., p. 111.
hæmorrhoidale Lec., Ann. Lyc. 1, p. 170, t. 11, f. 4.
apicale Mann., Bull. Mosc., 1843, ii, p. 258.
ruficorne Lec., Synop. loc. cit., p. 111.
triste Lec., l. c., p. 111.
var. *fusculum* Lec., loc. cit., p. 111.
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AXINOCERUS, n. g.

americanus, n. sp.

ANTHRENUS.

Geoffroy, Inst. Envir. Par. i, 1764, p. 113.

scrophulariæ Linn., Syst. Nat. i, 2, p. 568.
var. *flavipes* Lec., Synop., p. 112.
var. *thoracicus* Mels., Proc. Acad. Phil. ii, p. 117.
lepidus Lec., Synop. loc. cit., p. 112.
varius Fabr., Syst. Ent., p. 60.
var. *destructor* Mels., loc. cit., p. 116.
museorum Linn., Fauna Suec., p. 145.
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claviger Er., Nat. Ins. iii, p. 458.

APSECTUS.

LeConte, Proc. Acad. Phil., 1854, p. 113.

hispidus Melsh., Proc. Acad. Phil. ii, p. 117; Lec., loc. cit.

ORPHILUS.

Erich., Nat. Ins. iii, 1846, p. 461.

glabratus Fabr., Syst. El. i, p. 109; Er., loc. cit., p. 462.
ater Erich., loc. cit., p. 463.
subnitidus Lec., Proc. Acad. Phil., 1861, p. 344.

Explanation of Plate.

Fig. 1. Underside of **Byturus unicolor** Say.
Fig. 2. Posterior coxal plate of **Byturus**.
Fig. 3. Tarsus of the same.
Fig. 4. Antenna of **Byturus unicolor** Say.
Fig. 5. **Byturus grisescens** Lec.
Fig. 6. Antenna of the same.
Fig. 7. Antenna of **Dermestes**.
Fig. 8. Underside of prothorax of the same.
Fig. 9. Posterior coxal plate of the same.
Fig. 10. **Dermestes marmoratus** Say
Fig. 11. " **fasciatus** Lec.
Fig. 12. " **murinus** Linn.
Fig. 13. " " var. **caninus?**
Fig. 14. " **lardarius** Linn.
Fig. 15. " " var. **signatus** Lec.
Fig. 16. " **pulcher** Lec.
Fig. 17. " **elongatus** Lec.
Fig. 18. Antenna of ♂ **Attagenus Hornii**, n. sp.
Fig. 19. " ♀ same.
Fig. 20. " ♂ **Attagenus varicolor**, n. sp.
Fig. 21. " ♀ same.
Fig. 22. " ♂ **Attagenus piceus** Oliv.
Fig. 23. " ♀ same.
Fig. 24. **Attagenus Hornii**, n. sp.
Fig. 25. Prosternum and mesosternum of the same.
Fig. 26. **Attagenus piceus** Oliv.
Fig. 27. " **varicolor**, n. sp.
Fig. 28. Prosternum and mesosternum of the same.
Fig. 29. **Attagenus pellio** Linn.
Fig. 30. Prosternum and mesosternum of the same.
Fig. 31. **Dearthrus longulus** Lec.
Fig. 32. Prosternum and mesosternum of the same.
Fig. 33. Antenna of ♀ of the same.
Fig. 34. Posterior coxal plate of **Perimegatoma**.
Fig. 35. Underside of prothorax of the same.
Fig. 36. Elytral markings of the same.
Fig. 37. Antenna of ♂ **Perimegatoma cylindricum** Kby.
Fig. 38. " ♀ same.
Fig. 39. " ♂ **Perimegatoma variegatum** Horn.
Fig. 40. " ♀ same.
Fig. 41. " ♂ **Perimegatoma falsum** Horn.
Fig. 42. " ♀ same.
Fig. 43. " ♂ **Perimegatoma Belfragei** Lec.
Fig. 44. " ♀ same.

Fig. 45. **Acolpus primus**, n. sp.
Fig. 46. Head and antennæ of ♂ **Trogoderma ornata** Say.
Fig. 47. Antenna of ♀ same.
Fig. 48. Underside of head and prothorax of the same.
Fig. 49. Prosternum and mesosternum of the same.
Fig. 50. " " " **Trogoderma sternale**, n. sp.
Fig. 51. **Trogoderma simplex**, n. sp.
Fig. 52. Underside of head and prothorax of the same.
Fig. 53. Head and antennæ of **Trogoderma inclusum** Lec.
Fig. 54. **Cryptorhopalum balteatum** Lec.
Fig. 55. Antenna of ♂ **Cryptorhopalum hæmorrhoidale** Lec.
Fig. 56. " ♀ same.
Fig. 57. Underside of prothorax of **C. apicale** Mann.
Fig. 58. Antenna of ♂ same.
Fig. 59. " ♀ same.
Fig. 60. Thorax of **Cryptorhopalum triste** Lec.
Fig. 61. Thorax of **Cryptorhopalum ruficorne** Lec.
Fig. 62. **Axinocerus americanus**, n. sp.
Fig. 63. Antenna of the same.
Fig. 64. Side view of the head and thorax of the same.
Fig. 65. " " " " **Anthrenus**.
Fig. 66. **Anthrenus scrophulariæ** Linn.
Fig. 67. " " var. **flavipes** Lec.
Fig. 68. " " var. **thoracicus** Mels.
Fig. 69. Antenna of the same.
Fig. 70. **Anthrenus varius** Fabr.
Fig. 71. Antenna of the same.
Fig. 72. " **Anthrenus museorum** Linn.
Fig. 73. " **Anthrenus claviger** Er.
Fig. 74. **Apsectus hispidus** Mels.
Fig. 75. Antenna of ♂ of the same.
Fig. 76. " ♀ of the same.
Fig. 77. Prosternum and mesosternum of the same.
Fig. 78. **Orphilus glabratus** Er.
Fig. 79. Antenna of the same.
Fig. 80. Mesosternum and femora of the same.
Fig. 81. Posterior coxal plate of the same.
Fig. 82. Half of the underside of thorax of the same.
Fig. 83. Anterior leg of the same, lower surface.
Fig. 84. " " " " upper "

Stated Meeting, July 21, 1882.

Present, 3 members.

Dr. CRESSON, in the Chair.

Letters of acknowledgment were received from Dr. B. A. Gould of Cardova; the Musée Guimét; the Soc. Zoologique de France; Royal Irish Academy; and Adelaide Observatory.

A request from the Meteorological Society of London, 1838–40, was on motion granted.

On the President's recommendation it was ordered that the Leander McCormick Observatory of Virginia University be placed on the list of correspondents to receive the Proceedings.

A copy of Proceedings No. 111, just published, was laid on the table for inspection.

The copy of Dr. G. B. Wood's portrait in the University, by Miss M. W. Lesley, ordered by the Society, was exhibited.

Donations for the Library were received from the Asiatic Society of Japan; the Natural History Societies at Emden, Geneva and Bonn; the Academies at Brussels, Turin and Rome; Prof. E. Renevier, Lausanne; the Soc. de Geographie; Prof. Persifor Frazer; M. H. Brocard, of Paris; the Société Geographie Commerciale, Bordeaux; the Revista Euskara, Pamplona; Royal Astronomical Society, Journal of Forestry and Nature, and Messrs. William Tebb and G. J. Symons, of London; the Field Naturalist of Manchester; the Mitchell Library of Glasgow; the Literary and Historical Society of Quebec; the Observatory at Yale College and Prof. E. Loomis; Connecticut Academy; American Journal of Science; Essex Institute; Boston Society of Natural History; Prof. W. M. Davis; American Journal of Medical Sciences; Franklin Institute; Journal of Pharmacy, Library Company and Mercantile Library at Philadelphia; Prof. J. S. Newberry; U. S. National Museum; Chief of Engineers; Coast Survey; Edward C. Pickering; Historical and Geological Society at Wilkesbarre; Ohio Mechanics' Institute; Antiquarian and Oriental Journal; Minnesota Academy, and Adelaide Observatory.

Pending nominations Nos. 959 to 963 were read and balloted for and the following were declared duly elected members:

Prof. Léon de Rosny, of Paris.

Hon. Edward Sêve, Consul Gen. Belgium to U. S. A.

Mr. Joseph Snowden Bell, of Philadelphia.

M. Gaston Planté, of Paris.

Mr. Alexander Graham Bell, of Washington, D. C.

And the meeting was adjourned.

Stated Meeting, August 18, 1882.

Present, 3 members.

Curator, Mr. PHILLIPS, in the Chair.

Letters accepting membership were received from Mr. J. Snowden Bell, dated Philadelphia, 913 Walnut Street, July 26, 1882.

From Mr. Alexander Graham Bell, dated McCurdy Cottage, Newport, R. I., Aug. 7, 1882.

And from Mr. Léon de Rosny, dated Paris, No. 47 Avenue du Quêsne, Aug. 5, 1882.

Acknowledgments of the receipt of publications were received from the R. A. Amsterdam (105, 106, 107, 108, List, XV, iii); the Society at Würtemberg (107, 108, XV, iii); the Zoological Society in Amsterdam (109); the London Statistical Society (109); the Geological Survey of Canada (110, 111); the Maryland Historical Society (111); the Museum of Comp. Zoology (111) and Mr. A. Agassiz (111).

Envoy letters were received from the R. A. Amsterdam; the Bib. Nat. Vitt. Em. at Rome; and the Greenwich Observatory.

Donations to the Library were received from the Frankfort Zoological Garden; the Vienna Anthropological, Geological, Zoological and Meteorological Institutions; the Berlin Acad-

emy and Geological and Horticultural Societies; the Societies at Stuttgard and Göttingen; the two Academies in Rome, and the R. Geological Commission; the Paris Museum N. H., Bureau of Longitudes, Annales des Mines, Ethnological, Anthropological, Geographical and American Societies, Ecole Polytechnique, International Congress of Orientalists, M. C. Schnœbel, M. M. Loewy, and Revue Politique; the Guimét Museum at Lyons; the Geographical and Linnean Societies at Bordeaux; the Abbeville Society of Emulation; the Brussels Academy and Statistical Commission; the British Association, the London Astronomical, Meteorological, Geographical, Geological, Zoological, Asiatic and Antiquarian Societies; the Greenwich Observatory; the Edinburgh Royal Society; the Cornwall Polytechnic Society; the Melbourne Surveyors, and Inspectors of Mines; the Royal Society of Canada at Ottawa; the Essex Institute; Am. Antiquarian Society; Museum of C. Zoology; Am. Journal of Science; N. Y. Meteorological Observatory; Long Island Historical Society; Franklin Institute; Engineers' Club; Journal of Pharmacy; Academy of N. S. of Philadelphia; Johns Hopkins University; U. S. Signal Bureau; War Department; Census Bureau; National Museum and Fish Commission.

The death of Gouverneur K. Warren, Lieu.-Col. U. S. A., at Newport, R. I., Aug. 8, 1882, was announced.

The death of Viscount De Rougé (the announcement of which had been omitted) was ordered to be placed on record.

Dr. Genth read a paper entitled "Contributions from the Laboratory of the University of Pennsylvania. XX. Contributions to Mineralogy."

New nominations Nos. 964, 965, 966, 967, 968 were read; and the meeting was adjourned.

CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF PENNSYLVANIA.

No. XX.

CONTRIBUTIONS TO MINERALOGY.

BY F. A. GENTH.

(*Read before the American Philosophical Society, August 18, 1882.*)

I. In a paper, read before the American Philosophical Society on September 19th, 1873, I communicated some observations on the occurrence of *Corundum*, and, especially, on its alteration into other minerals. Since then I had an opportunity to examine many beautiful specimens of the same kind, by which my views on the subject received the fullest confirmation. I was in hopes that I would be able to prepare a second edition of my paper, illustrated with carefully drawn figures of the most important and striking forms, but, finding that my time is too much taken up by other duties, I fear that I shall never accomplish my desire, and, for this reason, will place on record, as an appendix to my first paper, the description of a few very remarkable occurrences.*

* In his Handbuch der Mineralchemie, 2 Auflage, Leipzig, 1875, Prof. C. F. Rammelsberg repeatedly refers to the above investigation, but, unfortunately, gives me credit for statements which I never have made. As they are of too much importance to remain uncontradicted, I will briefly allude to the most striking.

On page 147 (Specieller Theil), he says that I came to the conclusion that "*at the time, when chrysolite changed into serpentine, corundum was formed, which, subsequently, was altered into other minerals,*" while I simply state the fact that the largest deposits of corundum occur in serpentine, or in chrysolite, or the rocks immediately adjoining the same, and I do not even intimate that they were formed at the time when the latter changed into the former, as they occur equally in both; that I do not suppose (as Prof. R. seems to believe) that the alumina was eliminated from rocks which do not contain any appreciable quantity of it, is, I should think, sufficiently indicated by my query, "*by what agencies such enormous quantities of alumina could have been precipitated to form corundum?*"

On page 137, in quoting some of my analyses of the black spinels (ceylanites), Prof. Rammelsberg remarks that *their purity was very doubtful*, and that *besides the 4.31 per cent. of corundum*, which were eliminated during the process of analysis, *it must contain 9.6 per cent. additional.* If Prof. Rammelsberg had read my paper with the least attention, he would have found that I come pretty nearly to the same conclusion, for I say: "*that the most carefully selected material still contained a mechanical admixture of 13.36 per cent. of corundum.*" How little Prof. Rammelsberg seems to appreciate the drift of the whole investigation, is proved by the fact that he attacks the purity of my mineral species, when I never intended to publish these analyses as those of typical specimens of spinel, but, on the contrary, as *mixtures*, still showing remnants of the original species, and I distinctly say: "*This analysis, however, establishes the very important fact of the mechanical admixture of corundum.*"

On page 182, Prof. Rammelsberg says: "*According to Hunt bauxite is changed into corundum by strong ignition, and* GENTH THINKS THAT THIS ALTERATION TAKES PLACE AT ORDINARY TEMPERATURE ALSO." Now, the second part of the sentence

1. Corundum, altered into Spinel.

a. At the Carter Mine, in Madison county, N. C., corundum is found in white and pink crystals, but mostly in irregular grayish-white or white cleavage masses, generally enveloping a variety of a delicate pink color. Where small cracks or fissures occur in the corundum, it can be observed, sometimes only by a small dark line, that a change has commenced which in many places extends through large masses, converting the corundum into a massive greenish-black spinel, with uneven fracture, and of a fine granular structure, rarely showing planes of octahedral crystals in the compact mass. It yields a grayish-green powder and has a specific gravity of 3.751. The spinel shows in many cases small scales of prochlorite, into which it finally passes.

With difficulty I have selected some which was free from prochlorite, but although the material appeared to be quite pure, it was found to contain a small quantity of unaltered corundum = 1.15%. The following are the results of my analysis (a), and after deducting silicic acid and corundum (b), calculated composition (c).

		a.		b.		c.		
Al_2O_3	=	66.02	—	66.74	—	$FeFe_2O_4$	=	1.94
Fe_2O_3	=	1.33	—	1.34		$FeAl_2O_4$	=	27.53
CuO	=	0.09	—	0.09		$CuAl_2O_4$	=	0.21
NiO	=	0.33	—	0.33		$ZnAl_2O_4$	=	0.50
ZnO	=	0.22	—	0.22		$NiAl_2O_4$	=	0.78
FeO	=	11.81	—	11.94		$MgAl_2O_4$	=	69.04
MgO	=	19.13	—	19.34				
SiO_2	=	0.24	—	—				
Corundum	=	1.15	—	—				
		100.32		100.00				100.00

b. At the meeting of the American Philosophical Society of March 17, 1882, Dr. Edgar F. Smith and Mr. N. Wiley Thomas described corundum from a locality, three-quarters of a mile north of Shimersville, in Lehigh county, where numerous crystals had been ploughed up. I am indebted to Dr. Smith for a variety of specimens. The crystals are mostly rough, and show the hexagonal prism and pyramid and basal planes. Many of them have some feldspar and mica attached, showing that they probably come from a granitic gangue. The color of the crystals is generally gray, a few, however, show a reddish or a pink color. Disseminated through all the crystals and frequently accumulating on the surface, are minute, very brilliant crystals of a highly titaniferous menaccanite; these are *not*

which he saddles on me, is Dr. Hunt's. I positively deny the possibility of such a change in the following language: "*I do not know of a single instance in which corundum could have eliminated under such circumstances from the hydrate; on the contrary, the presence of grains of corundum in the bauxite proves pretty conclusively that the latter results from the hydration of corundum, and that the grains which have been found are remnants, not yet converted.*"

magnetic. It appears that this corundum has not been altered to a very great extent, only a few specimens of black spinel in irregular masses or rounded, pyramidal forms have been found, besides these only very thin yellowish or greenish, soft coatings, in very minute quantity, which may be a potassium mica. I could not get enough for examination. The spinel has an iron-black color, and is slightly magnetic. Its specific gravity is = 4.056.

Mr. George M. Lawrence has made an analysis of it in the Laboratory of the University of Pennsylvania, and found, after deducting 1.47% of silicic acid as follows (a); the calculated composition (b).

		a.			b.
Al_2O_3	=	56.42	$MgAl_2O_4$	=	25.40
Fe_2O_3	=	13.17	$FeAl_2O_4$	=	48.51
FeO	=	22.95	$FeFe_2O_4$	=	26.09
MgO	=	4.94			
TiO_2	=	2.62			100.00
		100.10			

The titanic acid is present evidently as a mechanical admixture of menaccanite $FeTiO_3$; deducting this and 24.16% of corundum, the composition of the pure spinel is given under (b). I do not consider the $FeFe_2O_4$ a mechanical admixture of magnetite, as it cannot be dissolved out by hydrochloric acid.

2. Corundum, altered into Zoisite.

This is one of the rarer forms into which corundum is altered. I will add, therefore, Towns county, Georgia, as a new locality, where it occurs in small quantity.

The corundum is of a beautiful pink color, surrounded by greenish-white, cleavable zoisite.

3. Corundum, altered into Feldspar and Mica (Damourite).

When my first observations on the alterations of corundum were published, I expressed some doubt about the feldspar, as having been the results of such a change, because I had then not seen any specimens which gave positive evidence of it, although even at that time there was a great probability that a substance which, beyond any question, was found to be altered into fibrolite, cyanite, mica, zoisite, &c., could also, without difficulty, be converted into feldspars. Since then I have seen many specimens which remove my last doubts and prove that most of the occurrences, referred to in my paper, are the results of alteration. In addition to those already mentioned, I will give a few data which may be of interest:

a. I had mentioned a granular, yellowish or brownish-white oligoclase from Unionville, as the probable result of such a change. At the same

locality we find occurring in small quantities, remnants of crystals of gray corundum, generally surrounded by a little silvery mica in fine scales, in brownish-white or light brown cleavable feldspar, in masses sometimes from 25 to 30^{mm} in diameter. The feldspar shows distinct triclinic striation. The corundum, where it is in contact with the feldspar or the micaceous coating, has a corroded appearance. The analysis gave:

SiO_2	=	62.62	contains oxygen	33.36	
Al_2O_3	=	22.59	" "	10.55	= 3.6
Fe_2O_3	=	0.22	" "	0.06	
MnO	=	trace			
MgO	=	0.18	" "	0.07	= 2.89
CaO	=	1.94	" "	0.56	
Na_2O	=	7.41	" "	1.91	
K_2O	=	2.52	" "	0.35	
Ignition	=	2.45			
		99.93			

This feldspar, after its fine powder had been dried over sulphuric acid for several days, gave on ignition 2.45 % of water and, in another sample, 2.55 %. As there is not a sufficient amount of bases R_2O and RO present for oligoclase, may not a portion of this water be basic water?

b. Another interesting occurrence of the alteration of corundum into a feldspar, is that at the "Black Horse" tavern, near Media, in Delaware county. The corundum, of a dark gray color in rough crystals, generally coated with a film of fine scaly mica, is imbedded in a finely granular brownish-white feldspar, which has probably resulted from its alteration. It has a specific gravity of 2.611, and the mean of two closely agreeing analyses, is as follows:

SiO_2	=	58.42	contains oxygen	31.16	
Al_2O_3	=	23.14	" "	10.82	= 10.87
Fe_2O_3	=	0.18	" "	0.05	
MnO	=	trace			
MgO	=	0.35	" "	0.14	= 3.45
CaO	=	3.13	" "	0.89	
SrO	=	trace			
BaO	=	2.56	" "	0.27	
Na_2O	=	3.68	" "	0.95	
K_2O	=	7.06	" "	1.20	
Ignition	=	1.54			
		100.06			

The constituents of $R_2O(RO) : R_2O_3 : SiO_2$ are in the ratio of 3.45 : 10.87 : 31.16, which is = 1 : 3.1 : 9, or almost exactly that of oligoclase.

It is an interesting fact that a part of the calcium oxide is replaced by barium oxide.

c. The Presley Mine in Haywood county, N. C., has furnished some very remarkable specimens of corundum, altered into feldspar as well as mica (muscovite).

α. The corundum at that Mine is generally of a grayish-blue color, sometimes in large crystals, more or less altered into the two minerals mentioned. Frequently in the interior of the crystals, when the altering agents had access by fissures or otherwise, small patches of white, cleavable feldspar may be seen, often, but not always, surrounded by mica. In other specimens, very little of the original mineral is left, and the grayish blue, deeply striated nucleus of corundum is surrounded by an aureole of exceedingly delicate, subfibrous mica (damourite) variable in thickness from 1 to over 20^{mm} in diameter. When in immediate contact with the corundum the altered mineral is generally almost compact and scarcely presents a crystalline structure, farther away from it, it becomes more scaly, the scales increasing in quantity and size; often large plates are mixed with very fine scales of mica. The color of the compact and subfibrous mica is generally of a very delicate pink, but sometimes also white with silky lustre; the scales are mostly white with a yellowish or silver-gray tint. Masses of such, partly altered corundum, of over 150^{mm} in diameter have been found, containing nuclei of nearly unaltered corundum of from 10 to 100^{mm} in diameter, sometimes showing the beginning of a change into mica and albite, where the alteration has been facilitated by fissures.

β. A very remarkable specimen from the same mine is an imperfect crystal of muscovite with plates of 35^{mm} in diameter, showing three or four sides of a six-sided prism. The upper and lower part of the original crystal are broken off, but it is still over 50^{mm} in height. It has an eminently basal cleavage, easily splits into thin elastic laminæ and has a brownish-gray color. In the center of the crystal and also in the lower part are remnants of smooth, bluish-gray cleavable corundum from 8 to 10^{mm} in diameter. On the exterior portion of the muscovite are small quantities of albite.

γ. The alteration of corundum into muscovite and albite is perhaps still better represented by a specimen, consisting of an imperfect crystal of muscovite of a brownish-gray color, of over 80^{mm} in diameter and a thickness of 40^{mm}, to which is attached, especially on one side, white, cleavable albite. The whole specimen is over 150^{mm} long, about 85^{mm} broad and 45^{mm} thick. Disseminated through the mass, both the mica and the feldspar, are remnants of crystals of grayish-blue corundum. Generally there is a thin seam of mica between the corundum and feldspar, but, in many places, the latter is in immediate contact with the corundum. The corundum shows distinctly the action of dissolving agents, it is rounded, smooth, as, if waterworn, sometimes corrugated, etc.

The whole mass has the appearance of a coarse granite, in which the quartz is replaced by corundum.

The corundum closely resembles the coarse crystals which are associated with mica and feldspar at Ilmensk and the River Barsovka in the Ural.

The analysis of the broadly foliated muscovite (c 1), that of the albite (c 2).

d. Very interesting varieties of altered corundum have been discovered by Mr. J. A. D. Stephenson of Statesville, N. C., at Belt's Bridge, Iredell county, N. C. The corundum has a gray and grayish-white color, and occurs in masses, sometimes over a foot in diameter, but generally smaller; they are irregular in form, always more or less rounded, sometimes globular, egg-shaped, rarely pyramidal and showing yet the crystalline form of corundum, but of the original mineral, many of the globular masses do not contain a trace, others contain small particles, disseminated through the mass, or a nucleus in the center. The altered mineral is mostly mica (damourite) some of the specimens also contain black tourmaline in radiating crystalline masses, which sometimes start from the corundum nucleus, but not always. The mica is either compact, of a grayish-white color or subfibrous (analysis (d1) by Miss Mary T. Lewis, after deducting 3.51 of corundum), and very fine scaly with pearly lustre, the scales rarely assume a size of more than 2^{mm} in diameter. In one of the specimens in which all the corundum has disappeared, I noticed minute cavities, containing fragments of a vitreous mineral which appears to be quartz, but the quantity was too small for further examination.

In connection with this, I will mention a specimen from the same locality, received by Col. Joseph Willcox. It appears to be a fragment of an irregular hexagonal prism, a little over 100^{mm} high, and somewhat less broad. The original form is scarcely perceptible, the sides being rounded and rough. There is a core of unaltered gray corundum of 65×55^{mm} surrounded with subfibrous, and on the outside with scaly mica, inclosing bunches of radiating, black tourmaline; disseminated through the unaltered corundum are many rounded masses of a brownish-red garnet from 4 to 6^{mm} in diameter, an association which I never before have observed. The analysis of the subfibrous mica, surrounding this corundum, which has been made by Mr. Frank Prince shows that a portion of the alkalies has been replaced by lime (d2).

e. In 1876 corundum was discovered in the micaceous schists near Bradford, Coosa county, Alabama, of which numerous specimens have been kindly presented to me by Dr. Eugene A. Smith, State Geologist of Alabama.

It is usually found in hexagonal prisms, but also in pyramidal form, apparently $\frac{1}{2}$–2, always, however, very rough and altered.

The corundum itself is of a brown and bronze color; sometimes exhibiting a star of six rays. Amongst the large number of specimens which I have examined, I have never seen one which was free from an admix-

ture of grains of menaccanite; in some of the crystals there were only a few small ones, rarely over one millimetre in size, in others, the quantity, disseminated through the corundum, is very large, and a great portion, probably in the act of crystallization, has been pushed to the outside of the corundum crystals, and gives them a coating of menaccanite, which sometimes reaches a thickness of 5mm. The menaccanite grains have no distinct form, they have an iron-black color, and, on a fracture, submetallic lustre, they are not magnetic, and gave the following composition:

TiO_2	=	17.62
Fe_2O_3	=	67.36
Al_2O_3	=	3.73
FeO	=	11.14
MgO	=	0.27
SiO_2	=	0.41
		100.53

The only alteration of this corundum which I have noticed, is that into mica and small quantities of tourmaline, but the specimens which have been obtained from this locality are the most beautiful and of great scientific interest.

The brown corundum is surrounded with greenish-white subfibrous mica, showing under a good magnifier a very fine scaly structure; this mica is sometimes only a very thin coating, but frequently from 2 to 5mm in thickness, surrounded by fine scaly mica, much of which has changed to brown scales with submetallic lustre, which largely exfoliate when heated, like jefferisite or maconite. In some specimens the subfibrous mica peels off and then shows the edges of the corundum rounded, and the whole surfaces acted upon, as if by a solvent; other specimens contain a core of brown corundum with the star of six rays; the corundum still shows the *rounded* hexagonal form, but the subfibrous greenish-white mica forms a ring around it with *perfect hexagonal sides* and sharp edges (analysis e), the whole being imbedded in fine scaly mica schist. Where many of such partly altered corundum crystals are crowded together in the mica schist, the appearance reminds one of plum pudding.

Many of the corundum crystals are almost completely changed into mica. Then they are often flattened out, and form irregular nodules in the mica schist, having a whitish or greenish-white color, are fine scaly on the surface (sometimes imbedding small slender crystals of black tourmaline), but compact or very fine granular in the interior. On breaking, some show yet minute traces of unaltered corundum; others have not a trace of it left, and have not the remotest resemblance to mica, but more the appearance of a grayish white compact limestone. Analysis of the compact mica (e2).

The menaccanite which was in the original mineral is also present in the altered.

PROC. AMER. PHILOS. SOC. XX. 112. 2W. PRINTED SEPT. 6, 1882.

The analyses gave:

		c 1	c 2	d 1	d 2	e 1	e 2
Spec. Grav.	=	2.640	— ———	— ———	— ———	— ———	— ———
SiO_2	=	65.52	— 45.26	— 45.96	— 44.03	— 44.54	— 45.00
Al_2O_3	=	22.25	— 36.33	— 38.22	— 40.16	— 36.52	— 36.08
Fe_2O_3	=	trace	— 1.96	— 0.61	— trace	— 3.26	— 2.73
MgO	=	———	— 0.14	— ———	— ———	— 0.37	— 0.72
CaO	=	1.96	— 0.35	— 0.37	— 3.14	— 0.23	— 1.01
Li_2O	=	———	— ———	— trace	— trace	— trace	— trace
Na_2O	=	9.54	— 0.48	— 0.74	— 1.42	— 0.65	— 1.35
K_2O	=	0.53	— 11.09	— 9.21	— 6.66	— 10.38	— 7.79
Ignition,	=	0.22	— 4.50	— 4.89	— 5.04	— 4.65	— 4.68
		100.02	— 100.11	— 100.00	— 100.45	— 100.60	— 99.36

f. Another locality which furnishes flattened nodules of mica, with a nucleus of corundum, is the Haskett mine in Macon county, N. C. They are mostly small, rarely over 10^{mm} in diameter, and contain a grayish-white corundum, surrounded by a subfibrous or fine scaly mica.

There are many other localities in which corundum altered into mica have been observed since the publication of my paper, but the specimens from them do not present any other than ordinary interest, I will therefore mention only a few localities: Franklin, Sussex county, N. J. (rare), Hogback, Jackson county, N. C., Cheohee, S. C., and also corundum from gravel beds, at the Placer mines at Gainesville, Ga., Brindletown and elsewhere in Burke county, McDowell county, etc., N. C.

4. Corundum, altered into Margarite.

The change of corundum into potassium mica is far more common than that into calcium mica or margarite.

a. One of the first observed in this State was brought to our notice by Prof. B. Silliman, in 1849, who published a description of that, found near Village Green (Am. Journ. of Sc. [2] viii, 378), of which he gives several analyses by Mr. W. J. Craw. When I published my paper on corundum, I did not notice this occurrence, as I had, at that time, not been able to examine any specimens. The corundum is of a dark brown color, showing sometimes, especially when wet, beautiful reflections of a rich bronze color and submetallic lustre. It is mostly in remnants of imperfect crystals imbedded in the altered mineral in scales of a silver white color and pearly lustre. I have also some specimens which are imperfect crystals having a core of unaltered corundum, surrounded with subfibrous and fine scaly margarite.

I will mention that the locality formerly known as Village Green is *now* Samuel Smith's farm (formerly Isaac Morgan's), Aston township, Delaware county, Pa.

b. At the Hogback Mine, Jackson county, N. C., most of the corundum which is altered changes into muscovite, but margarite also occurs. It is found with corundum, associated with an earthy yellowish mineral, like that of Gainesville, Ga., mentioned in my first paper, in which it is imbedded in small white pearly scales, often fan-shaped and radiating from a center. I had only a small quantity of not quite pure material, of which I have made a partial analysis (b).

c. I have analyzed a specimen from Unionville, Pa., which is quite interesting:—

The mass consists of a greenish-white, compact mineral, showing only very slightly a fine granular structure. Interlaminated are very thin micaceous strata, separating the compact mineral into layers; the whole inclosing a nucleus of unaltered gray corundum. The outside of the mass is coated with a scaly mica, the individual scales varying from 1 to 2^{mm} in size, which is evidently the result of an alteration, showing in the first place the change of corundum into compact margarite, and secondly, the change of the latter into muscovite.

The analysis of the margarite, as pure as can be selected, is given below (c 1), but also a partial analysis of the resulting muscovite, but of material, containing an admixture of margarite (c 2).

d. Very remarkable specimens of corundum, usually surrounded by margarite have been found at Hendrick's farm, Iredell county, N. C. The corundum occurs in hexagonal crystals, sometimes tapering, as if they were very acute hexagonal pyramids, with basal plane. They are very perfect and from 50 to 125^{mm} in length, of a pale brownish or grayish-white color. Many of the specimens contain numerous cavities which in most cases are small and indistinct, so that it is difficult, if not impossible, to suggest, what may have produced them, others show a hexagonal form, but in one specimen, which contains larger cavities, some from 10 to 15^{mm} in size, very little doubt is left that the mineral which previously occupied them was corundum in crystals showing a hexagonal pyramid and prism.

The corundum from Hendrick's farm is always altered on the surface, which is enveloped by a coating of margarite, from 1 to 6^{mm} in thickness. It is rarely subfibrous and fine scaly, but mostly compact and more or less porous. It has some black tourmaline in small crystals or crystalline groups imbedded in it, and on its surface it is beginning to change into muscovite. Where the margarite is in contact with the corundum, the latter has become rough and eaten. The analysis of the purest from this locality gave me the results (d 1), a less pure specimen was analyzed in the Laboratory of the University of Pennsylvania by Mr. Frank Julian (d 2).

	b	c 1	c 2	d 1	d 2
Specific Gravity =	—	2.997	——	3.004	——
SiO_2 =	29.07	34.10	——	32.55	33.10
Al_2O_3 =	50.44	47.38	——	48.87	52.20
Fe_2O_3 =	trace	0.34	——	0.60	trace
MgO =	——	0.17	——	0.23	——
CaO =	11.63	9.20	——	10.48	8.44
Li_2O =	——	trace	——	trace	trace
Na_2O =	——	1.14	0.80	2.38	2.59
K_2O =	——	2.34	8.80	0.43	——
Ignition =	6.63	4.43	4.15	4.34	4.85
Corundum =	——	0.54	——	——	——
	——	——	——	——	——
		99.64		99.88	101.18

5. Corundum, altered into Fibrolite.

a. In my previous paper I mention an observation by Prof. C. U. Shepard that at the Falls of the Yantic near Norwich, Conn., small crystals of sapphire are completely surrounded by fibrolite. Since then, Prof. George J. Brush has kindly presented to me a specimen which is quite interesting. It is a fibrolite of a brownish-white color, and shows, if examined with a strong lens, disseminated through the mass, numerous particles or remnants of grayish-blue corundum from which the fibrolite was formed; but besides, there is implanted in the fibrolite, a small hexagonal crystal of brown corundum 5^{mm} long and 1.5^{mm} thick, which must have crystallized at the time when the fibrolite was formed.

b. Recently this rare alteration of corundum into fibrolite has been found in numerous specimens at Shoup's Ford, Burke Co., N. C.

The corundum occurs in a mica schist in crystals, varying generally between 20 and 75^{mm} in length and from 10 to 45^{mm} in thickness, it has a brown or a bronze color and many crystals exhibit a star of six rays. The crystals are frequently flattened, always altered on the surface, rarely to a depth of 5^{mm}. The alteration consists of an aureole of very fine fibrous and radiating white fibrolite.

It seems that subsequently the fibrolite underwent a partial alteration into mica, as the mica schist in which the crystals are imbedded contains still a large admixture of fibrolite.

c. I have very little doubt that the alteration, described by Sillem (Jahrb. für Mineralogie, 1851, 385), of corundum into *quartz* from Barsovka in the Ural is really that into *fibrolite*.

The altered mineral surrounds a core of unchanged corundum from which it radiates.

My opinion is supported by the fact that Sillem's description of this alteration is identical with mine of corundum into fibrolite; then, that quartz very rarely assumes a radiating structure; that fibrolite has nearly the hardness of quartz; and finally that his statement is not supported by an analysis.

6. Corundum, altered into Cyanite.

a. In the gravel, two miles West of Statesville, Iredell Co., N. C., an interesting specimen has been found, consisting of a nucleus of pink colored corundum, around which is crystallized pale blue cyanite which latter has evidently resulted from the alteration of corundum.

b. In some specimens which I have received since the publication of my first paper on corundum, I have observed that the coarsely-bladed crystalline masses of cyanite from Wilkes county, N. C., resulting from the alteration of corundum, are further changed into micaceous minerals. They are very finely granular, scaly, and show the bladed structure and cleavage of the original cyanite, and between the laminæ minute scales of mica and a little quartz.

They have a grayish to brownish-white color, faint pearly lustre. H = 2.5. sp. gr. = 2.920. The purest material has been analyzed by my son, Mr. F. A. Genth, Jr., who found :

SiO_2	=	35.58
Al_2O_3	=	49.42
Fe_2O_3	=	trace
MgO	=	trace
CaO	=	6.34
Na_2O	=	2.11
K_2O	=	3.01
H_2O	=	4.12
		100.58

This analysis would correspond to about 59 % of calcium-sodium-mica (margarite), 29 % of potassium mica (muscovite), 9.7 % of unaltered cyanite and about 2.6 % of quartz.

7. When were the Corundum Alterations formed?

In many of the gravel beds in the Southern States, especially in North Carolina and Georgia, corundum is frequently met with, very rarely associated with diamonds, but generally with gold, zircon, monazite, xenotime, brookite, octahedrite, rutile, menaccanite, chromite, magnetite, cyanite, garnet, epidote, &c.

The corundum is sometimes, but rarely found in crystals of the usual form, mostly in fragments and cleavage pieces with very sharp edges and angles, which hardly ever are water-worn. These fragments show that the minerals have been broken by a very great force which had acted upon them very rapidly. Many of these fragments give evidence that, at the time when the corundum was broken up, a great portion of it had already undergone an alteration into other minerals. The most frequent are muscovite, mostly in fine scales, sometimes in subfibrous coatings ; some also show feldspar, margarite, black spinel and tourmaline, and very rarely cyanite, usually containing a nucleus of corundum. The altered minerals, accord-

ing to their hardness are more or less water-worn and rounded, whilst the corundum which they enclose is quite sharp and angular, which fact proves that, *since the great gravel deposits were formed no alteration of the corundum has taken place in these deposits.*

II. Alteration of Orthoclase into Albite.

Orthoclase changed into albite is undoubtedly one of the most interesting alteration of one mineral into another. Numerous occurrences of it have been observed in Europe, but I am not aware that it ever was noticed in this country; I will therefore give the description of an occurrence from the neighborhood of Philadelphia.

At the gneiss quarries of Upper Avondale, in Delaware county, Pa., druses have some time ago been found, which are lined with crystals of albite, associated with those of muscovite, and rarely with beautiful, but very minute, crystals of white beryl in hexagonal prisms and many pyramids, small crystals and groups of black tourmaline and calcite in cleavage masses and small scalenohedra, $1^{\frac{1}{2}}$, and thin hexagonal plates, which had so much the form of muscovite crystals that, at first, they were thought to be pseudomorphs. Mr. Lewis Palmer, of Media, presented me with a number of specimens.

The albite appears in short, stout colorless or white crystals, mostly in twins, showing principally the planes *I. O. i-ī. 2-ī. i-3̄* and *1-ī.* and *1*; the latter plane very small and indistinct. Many of the crystals are very small and imperfect, and form a crystalline coating upon the cleavage masses, either directly upon a flesh-colored orthoclase or a grayish-white plagioclase intervening. I have analyzed perfectly colorless crystals (1).

Some of the specimens show conclusively that the albite is more recent than the orthoclase, and results from the decomposition of the latter, sometimes with the intermediate development of a plagioclase, and that the crystals and crystalline masses of muscovite have resulted at the same time, and contain the potassium oxide of the former orthoclase. The orthoclase which is associated with these albite crystals forms flesh-colored cleavage masses, which on the cleavage planes are bright and lustrous. The purest which with a strong lens appeared to be without admixture, was examined by my son, Mr. F. A. Genth, Jr. In their sections under the microscope it shows the rectangular reticulation characteristic of orthoclase, but disseminated through it, minute particles of plagioclase, giving proof of an incipient alteration (2).

One specimen; particularly is quite interesting. It is a mass of coarse cleavage particles of flesh-colored and white feldspars, with colorless albite crystals in cavities and crystals and scaly aggregations of muscovite and a little quartz. A cleavage crystal of flesh-colored orthoclase, especially on one side shows a rotten appearance, as if in part eaten away and one of the edges and planes is replaced by a lining of albite in the form of an imperfect crystal made up by an aggregation of many small

individuals, joined together. In other places the albite gradually pushes itself, as it were, into the orthoclase, leaving in many instances only a small nucleus of the flesh-colored feldspar in the white.

In other instances there is between the orthoclase and the crystals of albite a grayish or grayish-white cleavable feldspar with deep striation. The analysis (3) shows it to be a mixture of albite with oligoclase, the oxygen ratio between R_2O (RO) : Al_2O_3 : SiO_2 being = 1 : 3.1 : 10.6.

Although not in connection with the alteration of orthoclase into albite and muscovite, I will mention that at the same locality orthoclase has also been found in colorless crystals (4), and white cleavage masses (5) associated with imperfect crystal of muscovite.

The analyses gave the following results :

	1 Crystals of albite	2 Orthoclase, flesh-red cleavage mass	3 Albite and oligoclase, cleavage mass.	4 Crystals of orthoclase, colorless.	5 Orthoclase, white cleavage mass.
Spec. Grav.	2.604	2.555	2.620	2.595	2.572
Si_2O	68.52	64.53	65.22	65.84	65.03
P_2O_5	—	—	—	—	0.08
Al_2O_3	19.44	19.64	21.44	19.50	19.22
Fe_2O_3	—	trace	0.20	—	—
MnO	—	—	trace	—	trace
MgO	—	0.25	—	—	—
CaO	—	0.16	2.07	trace	0.32
BaO	—	—	—	0.08	—
Na_2O	11.42	1.77	9.36	3.93	1.71
K_2O	0.65	13.62	1.16	10.69	14.18
Ignition	—	0.71	0.58	0.22	0.13
	100.03	100.68	100.03	100.26	100.67

Such alterations of orthoclase into albite occur not only in the quarries of Upper Avondale ; in the lower quarries at Leiperville similar facts can be observed, although not so striking, many of the large orthoclase crystals showing small patches of a thin coating of a white feldspar, albite or oligoclase, in many places penetrating into the orthoclase to a considerable extent.

Oligoclase is very common in our gneissic rocks, often associated with orthoclase, and very probably it is the result of the alteration of the latter.

III. Alteration of Talc into Anthophyllite.

The suggestion which I made over 20 years ago (Am. Journ. Sc. [2] xxx, 200), that the chrome and nickel-bearing serpentines have resulted from the alteration of chrysolite, is, at present, I believe, generally admitted, since the numerous investigations of Tschermak, von Drasche,

Groth, Sandberger, and others, have established beyond doubt that this change from the one mineral into the other is almost universal.

At that time I have also shown that at Webster, Jackson county, N. C., a foliated talc has in a similar manner resulted from the alteration of chrysolite. The latter alteration has since been observed in most of the localities in the Southern States, where corundum deposits are found associated with chrysolite rocks.

In Pennsylvania, where the unaltered chrysolite rock has never been observed, a rock has been found which is its representative and contains the same constituents, only in different proportions. In North Carolina the granular chrysolite always contains small quantities of enstatite (bronzite), in Pennsylvania on the contrary we have an enstatite (bronzite) rock, containing small grains (from 5 to 10%) of chrysolite. It is best developed at Castle Rock, Delaware county, also near Wood's Chrome Mine in Lancaster county.

In all the chrysolite rocks small grains or crystals of chromite are disseminated through the mass of the rock; in the serpentine, which has resulted from the alteration of the chrysolite, these crystals or grains are still present and give evidence of the original mineral. This is also the case with a peculiar variety of talc, the so-called "indurated talc," which occurs a few hundred yards south-south-west from Castle Rock, Delaware county, Pa. It is compact, with a strong lens shows a cryptocrystalline, slightly scaly structure, and an impure grayish-olive green color. H = 2. Sp. Gr. = 2.789. Fracture splintery to subconchoidal; dull.

The analysis gave:

			Calculated:
SiO_2	=	62.48	61.92
TiO_2	=	trace	
Chromite	=	0.20	
Cr_2O_3	=	0.13	
Al_2O_3	=	0.59	
NiO	=	0.16	
FeO	=	4.95	5.57
MgO	=	27.60	27.86
Ignition	=	4.81	4.65
		100.92	100.00

This is a talc, in which about one tenth of the magnesia is replaced by ferrous oxide = $H_2 (Mg^9_{10} Fe^1_{10})_3 Si_4 O_{12}$, represented by the calculated analysis above given.

Talc is generally one of the *final* products of the alteration of other rocks and minerals, but in this case, it has suffered a very remarkable change into anthophyllite. It is enveloped by an aureole of a white or grayish-white mineral, radiating from the nucleus of talc, having a thickness of from a few to over 15^{mm}. The mineral is fibrous, of silky lustre

and shows a large cleavage angle, similar to amphibole; the terminal planes are either not developed or broken off. It incloses, like the original talc, grains of chromite. Its Spec. gravity was found to be 2.983. Besides my analysis (a) I will give, for comparison, the analysis by Dr. A. Brezina of the anthophyllite from Hermannschlag in Moravia (Tschermak's Mineral. Mitth., 1874, 247).

		Castle Rock.		Hermannschlag.
SiO_2	=	56.88	—	57.39
Al_2O_3	=	2.45	—	2.04
Cr_2O_3	=	trace	—	——
Fe_2O_3	=	——	—	0.42
FeO	=	9.20	—	6.53
MnO	=	0.28	—	——
NiO	=	0.17	—	——
MgO	=	28.50	—	29.08
CaO	=	——	—	0.69
Na_2O	=	0.18	—	——
K_2O	=	0.03	—	——
Ignition	=	2.28	—	2.56
		99.97		98.71

From the description of the mica globules from Hermannschlag, by Director G. Tschermak (Tschermak's Min. Mitth., 1872, 264) we learn that next to the anthophyllite-stratum and between it and the nucleus of biotite, is a stratum which has a seladon-green color, and appears to be a mixture of talc and chlorite, strongly altered. This observation is of very great interest in connection with the evident alteration of talc into anthophyllite, above described.

There is also an observation of Dr. F. Becke (Tschermak's Min. Mitth. [Neue Folge] iv, 450) who noticed the alteration of olivin into anthophyllite between the gabbro locality "Vier Linden" and the R. R. Station Rosswein in Saxony. The olivin shows in many places a commencing alteration into serpentine (*or talc?*), and is surrounded by a stratum of anthophyllite of from 5–6^{mm} in thickness. This seems to be an analogous case, first, the olivin altered into serpentine (*or talc*), and this subsequently changed into anthophyllite.

IV. Talc, pseudomorphous after Magnetite.

In the vicinity of Dublin in Harford county, Md., is a series of rocks, consisting principally of gneiss and micaceous schists. They are underlaid by a bed of talcose slate, changing in some places into a very superior quality of massive soapstone, from 12 to 15 feet in thickness. Immediately adjoining, and under the talcose slates and soapstone, and in most cases separated from them by seams of chlorite or chlorite slate, lies a very large bed of a beautiful variety of green serpentine, mottled and of darker and paler green colors, of about 500 feet in thickness, and under this, a bed

of mottled black serpentine of about 800 feet, and frequently imbedded in the latter, masses of the same dark green serpentine. This immense bed of serpentine, in its two varieties, rests upon chloritic slates, with numerous crystals of magnetite in octahedra and twins, so called hemitropes, and talc slates, and below these again occurs another, but smaller bed of green serpentine of about 180 feet in thickness, which like the other is underlaid by chloritic and talcose slates, followed by a third bed of green serpentine.

A titaniferous variety of magnetite is found in lenticular masses of various sizes, intercalated between the green serpentine and is frequently bounded on the hanging wall by chloritic slates.

The green serpentine is quarried for ornamental purposes as it admits of a very fine polish and can be obtained in many beautiful shades of light and dark green.

The chloritic slate is generally of a very fine scaly structure, sometimes the scales become larger, from 0.5 to 1^{mm} in diameter on an average, but rarely reaching 3^{mm}.

At one locality in this large belt, a coarse scaly chlorite, immediately in contact with talc slate, has disseminated through it numerous small octahedra of talc, pseudomorphous after magnetite, an alteration, which, if I am correct, has never been observed before. These crystals from 1 to 2^{mm} in diameter are of a silvery-white color and pearly lustre, the scales are arranged parallel to the octahedral planes, in the center is occasionally a small nucleus of magnetite, sometimes associated with pulverulent limonite.

This alteration of magnetite crystals into talc is of importance in connection with the steatite bed of 12 to 15 feet in thickness, to which I have above referred, because it shows that no good reason can be given to contradict the proposition that an entire magnetite bed has disappeared and has been replaced by steatite. This opinion is proved by the following observations.

The steatite is of a white or greenish-white color, it has mostly an uneven fracture, some seams in it, however, graduate into a slaty structure. Cryptocrystalline, and showing, when powdered, to be composed of an aggregate of exceedingly fine scales. *Disseminated through the whole mass are dark spots, from 0.1 to 10^{mm} in diameter.* Especially the larger ones sometimes have *a definite shape of squares or rhombs, or other forms, representing sections of magnetite crystals.* These dark spots of a dark gray or iron-black color, are quite soft and can be reduced to a powder by the nail of a finger, and consist of fine scaly talc, *colored by remnants of the original magnetite,* which frequently can be separated by a magnet, or dissolved out by hydrochloric acid. That only a small number of the dark spots show the form of sections of magnetite, whilst most of them are without definite shape, shows that the original magnetite in the bed was granular or compact, but had, as is very common, *crystals* of magnetite disseminated through the whole mass.

V. Gahnite.

a. Already in 1876, at the Centennial Exhibition, I observed, amongst minerals from Western North Carolina, a specimen which was so unlike any species with which I was familiar, that I was in doubt about its nature. A little fragment of it which I afterwards received I put provisionally under gahnite. About a year ago I recognized the same mineral again amongst others which Mr. W. E. Hidden had collected in North Carolina, who very kindly gave me some fragments for investigation, which proved it to be gahnite.

Apparently without form, a fracture between splintery and conchoidal, and of a very rich, dark green color, which can best be observed by transmitted light. H = 7.5. Sp. Gr. = 4.576. The analysis is given below (a), after deducting 0.09% SiO_2 and (a 2) the calculated results.

It occurs rarely at the Deake Mica Mine, Mitchell Co., N. C. The specimen at the Centennial Exhibition was about 4^{cm} long and 3^{cm} broad and, with an exception of thin micaceous coatings between fractures, was free from admixtures; Mr. Hidden's specimen was about 2 to 2.5^{cm} in size, and was surrounded by a thin coating of about 1^{mm} in thickness, consisting of yellowish-white fine scaly muscovite, evidently the result of alteration.

b. Last summer Mr. Charles E. Hall, of the Geological Survey of Pennsylvania, brought me for determination a number of specimens from the Cotopaxi Mine, Chaffee county, Colorado, which were found to be gahnite.

It occurs in large rough crystals, principally octahedra, some of the crystals show also the dodecahedral plane; the largest crystal which I have seen has an octahedral edge of 9^{cm} in length; the crystals are often distorted and flattened out by the enlargement of two opposite octahedral planes. Besides containing inclosures of galenite, and, in smaller quantity of chalcopyrite and pyrite, they are very much altered.

When in a pure state it has a dark blackish-green color, and an uneven to subconchoidal fracture. The material for the analysis was very carefully selected, and first treated with sulphuric acid to remove the impurities, resulting from its alteration. Mr. Harry F. Keller has analyzed it in the Laboratory of the University of Pennsylvania, and obtained the results (b), after deducting 1.85 per cent. of silica; (b 1) are the results calculated from the analysis:

	a		b			a 1		b 1
Al_2O_3	= 54.86	—	60.76	—	$CuAl_2O_4$	= 0.69	—	——
Fe_2O_3	= 4.50	—	0.58	—	$ZnAl_2O_4$	= 86.34	—	53.94
FeO	= 1.14	—	4.56	—	$FeAl_2O_4$	= ——	—	10.44
MnO	= 0.29	—	——	—	$MnAl_2O_4$	= 0.71	—	——
CuO	= 0.30	—	——	—	$MgAl_2O_4$	= 1.07	—	36.88
ZnO	= 38.05	—	23.77	—	$MgFe_2O_4$	= 2.46	—	——
MgO	= 0.79	—	10.33	—	$FeFe_2O_4$	= 3.67	—	0.84
				—	Al_2O_3	= 4.99	—	——
	99.93		100.00			99.93		102.10

The analysis *a* shows an excess of nearly 5 per cent. of alumina, which is remarkable, as the separations in the analysis were most perfect. This gahnite does not come from a corundum locality, and it is therefore improbable that any has been inclosed in it.

In Mr. Keller's analysis, 2.10 per cent. of alumina are wanting to form spinel, RR_2O_4.

c. Alterations of the Gahnite from Cotopaxi.

Even the best and purest specimens from this locality, which appear to be quite fresh, show innumerable cracks, breaking them up into small angular fragments.

a. In most instances these are coated with a white earthy mineral, which dissolves in strong boiling hydrochloric acid. A qualitative analysis shows this coating to be a hydrous silicate of alumina and magnesia, and it is probably the same substance which in thicker coatings, has a finely fibrous structure, a white or greenish-white color and silky lustre. The thickest were not over 3^{mm} in thickness, and were very much mixed with ferric oxide, and other impurities, some of them carbonates, as dilute hydrochloric acid liberates carbon dioxide. Does not exfoliate on ignition. The ignited mineral is readily decomposed by sulphuric acid.

The best material which I could obtain for analysis, although still very impure, was sufficiently pure to determine the position in the system where the mineral belongs. It was decomposed by sulphuric acid after ignition, then the silica extracted by sodium hydrate, and separated from this solution. About 6 per cent., insoluble in sulphuric acid and sodium hydrate, mostly gahnite, were deducted, and the following results obtained :

Ignition	=	13.82
SiO_2	=	28.08
Al_2O_3	=	18.20
Fe_2O_3	=	4.32
CuO	=	0.82
PbO	=	1.80
ZnO	=	1.75
MgO	=	29.85
		98.64

Lead and zinc are probably present as carbonates, the ferric oxide as such, if I therefore deduct these as impurities, the following composition, which places this mineral near ripidolite, will probably not be far from the truth.

SiO_2	=	31.68
Al_2O_3	=	20.54
MgO	=	33.68
H_2O	=	14.10
		100.00

β. Another alteration, shown by many of the crystals, is that into a micaceous, chloritic mineral. It either forms a coating parallel with the octahedral planes or penetrates the crystals irregularly in every direction.

It has a white, grayish- or greenish-white color, is sectile and very little elastic. On ignition it does not exfoliate, but turns silver-white. The ignited mineral is easily decomposed by sulphuric acid. 0.2747 grms. although not quite, but nearly pure, was all that I could obtain for analysis, from which 0.0140 grms. insoluble in sulphuric acid and, subsequently, in sodium hydrate was deducted as impurity. The results were:

				Calculated:
SiO_2	=	31.15		32.58
Al_2O_3	=	13.12		13.95
FeO	=	10.74		11.40
CuO	=	0.77		——
ZnO	=	0.39		——
MgO	=	29.23		29.86
Ignition	=	11.78	H_2O =	12.21
Alkalies		?		——
		97.18		100.00

These results show the mineral to belong to the chlorite group, closely agreeing with the formula $H_{30}[Fe^{35}_{200}Mg^{165}_{200}]_{20}Al_6Si_{12}O_{68}$, for which I give calculated percentage above. It must remain undecided whether or not this is a new species, until larger quantities of pure material can be obtained for a fuller investigation.

VI. Rutile and Zircon from the Itacolumite of Edge Hill, Bucks County, Pa.

In the examination of a series of "Edge Hill rocks" which, according to Mr. Charles E. Hall (Report C6., of the 2d Geological Survey of Pennsylvania), are Potsdam sandstone, I have made a few observations which should be placed on record.

The rocks are generally thinly laminated quartzites which contain yellowish-white scales of muscovite in larger or smaller quantity, and are identical in appearance with the large mass of the "itacolumite" rocks of the Southern States, which do not show any flexibility.

Especially in Neeley's Quarry, but also in smaller quantity in many others, the rock contains exceedingly minute, yellowish, orange or brownish-yellow grains, they are smaller than 0.25^{mm}. By powdering and levigation I have obtained a considerable quantity of the same.

Under the microscope they appear as irregular, sharp, angular fragments, showing now and then a very smooth plane, but no distinct crystalline form. They have a honey-yellow color. B. B. they gave the reaction of titanic oxide, and a very minute trace of tin.

Associated with the yellow grains are small crystals of a dark brown almost black tourmaline, small crystalline plates of menaccanite and colorless or slightly yellowish and brownish-white zircons, the latter more or less water-worn, but showing the planes of the prism *I*, the pyramid 1 and also less distinct, the planes of the pyramids *ii*, and 33.

As it is an impossibility to pick out enough of the pure yellow grains for analysis, I made several unsuccessful attempts to analyze the mixture, and obtained by Pisani's method 79.07 % of titanic oxide.

I had, at the expense of one week's labor, picked out a little over two milligrams of *perfectly pure yellow grains*, which Dr. G. A. Koenig had the kindness to test by his colorimetric method, and pronounced to be *almost pure titanic oxide*, the yellow grains are therefore probably a variety of rutile.

In the rock itself the yellow grains show the same sharp angular forms above mentioned, whilst the zircons are water-worn. It appears from this that the rutile, tourmaline, mica and menaccanite crystallized or rather separated when or after the itacolumite was deposited, whilst the zircons, together with the quartz, are remnants of decomposed rocks, probably coming from granulites. In those of the South mountains, I have frequently observed microscopic zircons, very similar in form to those in the Edge Hill rocks. I may mention that Prof. Zirkel (Jahrb. f. Mineralogie, 1876, 90), has also detected microscopic zircons in the granulites of Saxony.

Artificial Rutile and Octahedrite.

Whilst decomposing some of the mixed yellow sands, containing about 80 % of rutile, by fusion with a rather small quantity of potassium hydrogen sulphate, I was interrupted in my work for several hours, so that the greater portion of the potassium hydrogen sulphate was converted into potassium sulphate. By dissolving in cold water most of the titanic oxide went into solution, but I noticed a pale brownish, heavy, sandy substance, which, under the microscope, appeared in very brilliant crystals of the usual form of rutile *I* and *ii*, and pyramids 1 and 1*i*. One or two of the crystals were twins. There were, perhaps, several hundred of rutile crystals. Amongst these I observed *two* crystals of *octahedrite* which had the acute pyramid 1 and a decided *blue* color.

Experiments which I subsequently made for the purpose of making these artificial rutile crystals from pure titanic oxide were not very successful; although I have repeatedly obtained microscopic quadratic forms, I never could get any distinct brilliant crystals.

VII. Sphalerite and Prehnite, from Cornwall, Lebanon Co., Pa.

a. Sphalerite.

About two years ago small crystals of a greenish mineral were discovered by Mr. E. E. Craumer, of Lebanon, Pa., associated with a white crystalline coating upon the magnetite of the great Cornwall Ore Bank.

Lebanon county, Pa. I am indebted to him and also to Mr. J. Taylor Boyd, the General Superintendent of the Cornwall Ore Bank, for about a dozen of these *exceedingly rare crystals*, which I have found to be *sphalerite*. Only two or three distinct crystals were obtained, which were octahedra in hemitrope twins. Most of the crystals are very much distorted or imperfect for want of space for their development.

In color, they are between asparagus-green, brownish-green and light brown. Spec. grav. = 4.033.

The largest crystals are between 4 and 5^{mm} in size. They occur in cavities of magnetite and are associated with a peculiar variety of prehnite, which sometimes envelops the sphalerite, magnetite, pyrite and crystallized chlorite, in small scales, frequently altered into a mineral resembling leidyite, which also envelops the magnetite crystals. There is too little of the latter for further examination.

The analyses of the sphalerite crystals gave the following results:

		1.		2.
S	=	32.69		33.06
Zn	=	66.47	}	
Co	=	0.34	}	66.96
Fe	=	0.38	}	
		99.88		100.02

b. Prehnite.

This occurs in crystalline incrustations upon magnetite, or as lining the cavities of the same. They consist of minute crystals and groups of crystals showing the planes *I*, *O*, and *ii*, forming frequently small globular, coxcomb and fan-shaped aggregations, colorless, white, yellowish and brownish-white. Sp. gr. = 3.042. The prehnite is the most recent formation, its incrustations covering magnetite, sphalerite, pyrite, chlorite and leidyite. The analysis of a carefully selected specimen gave:

SiO_2	=	42.40
Al_2O_3	=	20.88
Fe_2O_3	=	5.54
CaO	=	27.02
H_2O	=	4.01
Alkalies and MgO	=	traces
		99.85

VIII. Pyrophyllite in Anthracite.

At the meeting of the American Philosophical Society, of July 18th, 1879, I mentioned the very interesting occurrence of pyrophyllite in delicately fibrous incrustations from the Buck Mountain seam near Mahanoy City, Schuylkill county, Pa.

Identical in appearance and association it has lately been observed by

Mr. Oswald J. Heinrich, near Drifton, Luzerne county, in the Tomhicken Basin, which lies 75 feet above the Buck Mountain seam.

Another variety of pyrophyllite, which has the appearance of kaolinite, has also been found by Mr. Heinrich, near Drifton and Gowen, in the Buck Mountain seam. He has favored me with the following data, relative to its occurrence.

It is found principally in the upper bank of the seam which has a thickness of 5 to 6 feet and does not only occur in the planes of stratification and fissures, but even in the most compact anthracite. It has accumulated especially in layers or lenticular patches of from one-half to over one inch in thickness in the slate bank which divides the upper from the lower bank, and which has a thickness of from 8 to 15 inches, sometimes inclosing a few inches of anthracite. It is white or yellowish-white, compact, cryptocrystalline, slightly soils the fingers. Soft. Does not in the least exfoliate or expand on strong ignition. Sp. gr. = 2.812.

Not decomposed by sulphuric acid. The analysis of that from Cross Creek Colliery, near Drifton, Luzerne county, gave:

SiO_2	=	65.77
Al_2O_3	=	29.36
Fe_2O_3	=	0.12
H_2O	=	4.85
		100.10

IX. Beryl from Alexander Co., N. C.

Many beautiful varieties of beryl have lately been found in Alexander county, N. C., and Mr. Wm. Earl Hidden especially has brought to light many of the most interesting specimens. To him I am indebted for a fragment of a rounded pebble which has a slightly leek-green color, turning brown by oxidation. It has a pretty distinct cleavage in one direction. Its specific gravity was found to be = 2.703. The analysis proved it to be beryl. It contained:

SiO_2	=	66.28
Al_2O_3	=	18.60
Be_2O_3	=	13.61
FeO	=	0.22
Ignition,	=	0.83
		99.54

X. Allanite.

Mr. W. E. Hidden found in the "Hiddenite" vein, Alexander county, N. C., associated with quartz, white orthoclase and little mica, small brownish-red, brownish-yellow or light brown crystals, which have the appearance of a partial decomposition or hydration, and a resinous lustre.

Their analysis proved them to be allanite. Sp. gr. = 3.005. As the quantity for examination was very small the cerium oxides were not separated.

For comparison I give the analysis of a variety of allanite from the Mica Mine of Balsam Gap in Buncombe Co., N. C., where it occurs in jet black or brownish-black slender crystals, sometimes from six to twelve inches in length (Minerals, &c. of North Carolina, Raleigh, 1881). Spec. grav. = 3.400.—

		Alexander Co.		Balsam Gap.
SiO_2	=	32.05	—	32.79
Al_2O_3	=	22.93	—	18.16
Fe_2O_3	=	11.04	—	1.64
FeO	=	——	—	10.08
MnO	=	1.99	—	1.23
Ce_2O_3	=	14.81	—	6.07
$(DiLa)_2O_3$			—	14.40
Y_2O_3	=	0.85	—	1.84
MgO	=	1.28	—	0.15
CaO	=	9.43	—	10.95
Na_2O	=	0.54	—	0.33
K_2O	=	0.20	—	0.12
Ignition	=	3.64	—	1.89
		98.76		99.65

XI. Niccolite from Colorado.

In the American Journal of Science [3] xxiii, 380, Mr. Malvern W. Iles mentions the occurrence of smaltite near Gothic, Gunnison Co., Colorado, and gives an analysis of the same. He states that the Gem and other mines near Silver Cliff, Colorado, contain a number of nickeliferous minerals and a small amount of cobalt.

About two years ago I received fragments of niccolite from Colorado from some of my students, and about a year ago Mr. Henry A. Vezin sent me a specimen from Silver Cliff, which was pure enough for examination.

It occurs in rounded or nodular masses disseminated through a granular limestone, which has the appearance of dolomite, but contains only a very small percentage of magnesia. In dissolving the limestone, the niccolite remains in small irregular masses, partly made up by globular and botryoidal aggregations with a crystalline black surface, showing the crystals of niccolite to be exceedingly small and indistinct; I have not seen any in which the form could be made out. It has a very pale copper-red color with a grayish tint. Sp. gr. = 7.314.

Associated with it in druses of the limestone are globular crystalline groups of an apple-green mineral, which is probably an arseniate of nickel but which has not the appearance or annabergite.

PROC. AMER. PHILOS. SOC. XX. 112. 2Y. PRINTED NOV. 8, 1882.

The analysis of the niccolite gave:

As	=	46.81
Sb	=	2.24
S	=	2.52
Cu	=	1.59
Ni	=	44.76
Co	=	1.70
Fe	=	0.60
		100.22

This is a niccolite in which a small portion of the arsenic is replaced by antimony and sulphur.

XII. Artificial Alisonite (?).

About a year ago Mr. R. Pearce, Metallurgist of the Works of the Boston and Colorado Smelting Co., at Argo, Colorado, kindly sent me some very interesting crystals from furnace bottoms, which he had never before observed.

They were octahedral crystals, some showed cubical planes and slight indications of the dodecahedron; they were mostly distorted, cavernous, and many of them rounded, iron-black, and of metallic lustre. Spec. gr. = 5.545. Crystallized upon a plate of copper matte, containing a large percentage of metallic copper.

The analysis gave:

				Calculated.
S	=	15.23	—	17.61
Ag	=	2.16	—	——
Cu	=	51.33	—	49.84
Pb	=	31.15	—	32.55
Fe	=	trace	—	——
		99.87		100.00

The composition is similar to alisonite or nearer $2PbS$, $5Cu_2S$ in which part of the copper is replaced by silver. The small percentage of sulphur can be accounted for from a small admixture of metallic copper, with which some of the crystals were contaminated.

UNIVERSITY OF PENNSYLVANIA, August 17, 1882.

Stated Meeting, September 15, 1882.

Present, 4 members.

Vice-President, Dr. LE CONTE, in the Chair.

M. Woldemar Kowalevski, member of the I. Academy of St. Petersburg, was introduced.

M. Edward Sêve de Bar, accepted membership by letter, dated Philadelphia, August 31, 1882.

The death of M. Liouville, at Paris, Sept. 9, was announced.

Acknowledgments of the receipt of publications were received from the Ast. Gesell., Leipsig (109); the Cincinnati Observatory (109, 111); the Leop. Car. Gesell. Halle am Saale (109); and the Free Public Library of New Bedford (111).

Requests for missing numbers were received from the Leop. Car. Gesell. Halle am Saale (108, and pp. 483–498 of —-); and from the Paris Geographical Society (XIV, ii, and 62).

Donations for the Library were received from the Revista Euskara; Academy of St. Petersburg; Ant. and Hist. Society at Copenhagen; Academies at Amsterdam, Leiden, Harlem, Batavia, Brussels and Munich; Geographical Societies at Paris and Bordeaux; London Antiquarian Society and Nature; Cambridge University Library; Hist. Societies of New York and New Jersey; James Hall; Franklin Institute, Journal of Pharmacy and Dr. J. B. Roberts; U. S. National Museum, Fish Commission, Census Bureau and Coast Survey; Am. Chem. Journal, and Johns Hopkins University; Ohio Mechanics Institute, and Davenport Academy of Sciences.

Mr. Cope exhibited and described some remarkable new fossil forms from the Permian rocks of Texas, and communicated a "Third contribution to the history of the Vertebrata of the Permian formation in Texas."

The reading of nominations being dispensed with, the meeting was adjourned.

Photodynamic Notes, VI. By Pliny Earle Chase, LL.D.

(*Read before the American Philosophical Society, October 6, 1882.*)

242. *Stability of Harmonies.*

In Note 220, I presented several reasons for believing that the mean periods of planetary rotation are stable. They are all dependent upon more general principles which regulate the harmony of persistent oscillations in elastic media, and consequently furnish strong *a priori* presumptions against all hypotheses which seem, in any way, to conflict with harmonic tendencies. The certainty (Note 213), which Proctor admits, of Earth's having a pulsation period, with which its rotation must once have begun to approach to synchronism, springs from a like source with the harmonic tendencies in Jupiter's satellite system, and Laplace's reasoning is equally applicable to both cases. The "pulsation period" which is due to luminous vibration is constant, and if it should ever be suddenly or greatly disturbed, rotation would immediately begin again to approach to its normal synchronism. After the synchronism is once reached, all the influences from which it originated continue to contribute towards its perpetual maintenance.

243. *Improbability of Delaunay's Hypothesis.*

Newcomb and Holden (*Astronomy*, p. 148) close their note on the secular acceleration of the Moon, as follows:—"The present theory of acceleration is, therefore, that the Moon is really accelerated about six seconds in a century, and that the motion of the Earth on its axis is gradually diminishing at such a rate as to produce an apparent additional acceleration which may range from two to six seconds." The former portion is known to be cyclical, to be followed, after a long interval, by a corresponding retardation; there is not a particle of evidence to discredit the probability that the latter portion is also cyclical. Neither is there a particle of evidence that there is any tidal friction except at the shores of the ocean, where any accelerating tendencies at one period are counterbalanced by retarding tendencies at another. The frictional hypothesis was a gratuitous assumption, to explain a doubtful phenomenon, and although the explanation would be satisfactory if the frictional retardation could be proven, the assumption violates the ordinary rules of framing scientific hypotheses so completely, that its chief claim for consideration rests upon the reputation of its originator. On the other hand, the harmonic hypothesis makes no assumption; starting from acknowledged facts and principles, it asks what results may be reasonably anticipated, and there are few, if any, modern researches, in which the anticipations have been so abundantly verified. Even if we grant frictional retardation, there is "no way of determining the amount of this retardation unless we assume

that it causes the observed discrepancy between the theoretical and observed accelerations of the Moon" (*op. cit.* p. 147).

244. *Scientific Skepticism.*

Hesitation in the acceptance of alleged results, in any new line of scientific research, is an obvious duty on the part of those who are fitted and expected to be on the watch against the promulgation of hasty generalizations which would needlessly cumber the field of knowledge. There is danger, however, that even faithful watchmen may sometimes hinder scientific progress by failing to keep their skepticism within proper bounds. The fact of harmony, and especially of coördinated harmony, transcends all mathematical tests of probability. It would be a tedious, but not a difficult task, to find in how many ways the letters of the Iliad could be arranged, and it is often wrongly assumed* that in a purely accidental arrangement of the letters, the faultless one would be as likely to take place as any other. It would be no more absurd to inquire whether the music of an orchestra might not be accidental, than to make a like inquiry as to the rhythm of atoms and waves and spheres. When mathematical tests confirm the probability that special forms of harmony are due to special laws, as in phyllotactic, thermodynamic and fundamental atomicities, they are useful; but when they fail to give any reason for obvious accordances, as in Schuster's first examination of spectral lines (Note 141), they are utterly worthless unless they awaken further inquiries which lead to satisfactory results, as in Schuster's final conclusions.

245. *Centre of Dawning Condensation in the Terrestrial Belt.*

The intrinsic probability that the major axis of the Moon's orbit is invariable, is greatly enhanced by the following proportion:

$$r_3 : l_3 :: R_3 : L_3$$

Substituting the several known values, we have: r_3 = Earth's equatorial semi-diameter = 3962.8 miles; l_3 = Laplace's terrestrial limit = $\left(\frac{86164.1}{5073.6}\right)^{\frac{2}{3}} r_3$; R_3 = Moon's semi-axis major = $60.2778\, r_3$; L_3 = limit of incipient belt-condensation = $R_3 l_3 \div r_3$ = 1,578,217 miles. The oscillatory value of Sun's mass (Note 23, etc.,) gives, for the ratio of Earth's subsidence from the centre of the belt of greatest condensation, $L_3 \div \rho_3$ = 1,578,217 ÷ 92,785,700 = .0170093, and for the dawning central locus of the belt of greatest condensation, $1.0170093\, \rho_3$. The arithmetical mean between Stockwell's estimates of Mercury's secular perihelion and the secular aphelion of Mars is (.2974008 + 1.736478) ÷ 2 = $1.0169394\, \rho_3$. The difference between the two estimates is less than $\frac{1}{442}$ of one per cent

* See Note 252.

246. *Pendulum Estimate of Moon's Mass.*

In Note 8, I anticipated slight modifications of my first estimate of Moon's mass, as likely to be required by subsequent investigations. If we apply the principles which are involved in the coefficient of solar torsion, Note 162, to the determination of the length of Earth's theoretical pendulum, we find

$$l = g\left(\frac{t}{\pi}\right)^2 = \frac{32.088}{5280} \times (43082.05)^2 \div \pi^2 = 1,142,882 \text{ miles.}$$

From this equation we deduce the relative value of Moon's mass, μ, by the proportion,

$$\rho_3 : l : : m_3 : \mu$$
$$92,785,700 : 1,142,882 : : 81.1857 : 1$$

This estimate differs from the one in Note 8 by less than $\frac{1}{51}$ of one per cent.

247. *Rotation Estimate of Moon's Mass.*

The conviction, which I have often expressed (Note 220, etc.), that rotation is only modified revolution, is further strengthened by the following considerations. The orbital velocity (v_a) which the combined energies of Earth and Moon tend to give to an equatorial particle which is nearest to the Moon, is about 2.18 times as great as the velocity (v_β) which they tend to give to the mean centre of gravity of Earth's oscillating particles. The preponderating attraction of Earth prevents the action of these tendencies, in any other way than as accelerating disturbances on the several particles whose retarded and constrained revolution leads to axial rotation. The greater acceleration, acting for a half-monthly oscillation (t_a), gives the mean orbital velocity of the system (v_o), while the smaller acceleration, acting for a half-daily oscillation, gives Earth's equatorial velocity of rotation (v_r), as is shown by the proportion

$$v_o : v_r : : v_a t_a : v_\beta t_\beta$$
$$18.4735 : .288183 : : 14.7652942\, v_a : \tfrac{1}{2} v_\beta$$
$$v_a = 2.1798\, v_\beta.$$

If we designate the distances of the respective particles from the centre of gravity of the system by d_a and d_β, we have $d_\beta v_\beta^2 = d_a v_a^2$; $d_\beta = 4.7514\, d_a$. The theoretical mean intersections of d_a with Earth's surface should be on the equator, and those of d_β should be on meridians, but want of exact homogeneity, as well as orbital inclinations, may be presumed slightly to modify their respective loci. The mean centre of gravity of Earth's oscillatory particles is at the distance r from the surface, but they are all also affected by wave-lengths equivalent to d_a, so that we have $d_\beta = d_a + r = 4.7514\, d_a$. Hence $r = 3.7514\, d_a$; $d_a = .26657\, r = 1056.35$ miles; $d_\beta = 5019.15$ m.; $r - d_a = 2906.45$ m.; $m_3 + \mu = (238,869 \div 2906.45)\, \mu = 82.1858\, \mu$; $m_3 = 81.1858\, \mu$, a value which corresponds exactly with the one in the foregoing note.

248. *Harmonies of Central Condensation.*

The superficial intersections of d_a, in the foregoing note, describe circles about the poles, which have diametrical arcs of $5^\circ\ 10'\ 40''$, which differs by only $2'$ from the inclination of the Moon's orbit. If we take $1\times2\times3\times5$, the product of the first four phyllotactic numbers, as a divisor of Earth's diameter, calling the quotient a, we have the following approximate accordances:

Harmonic.	Observed,
$4\ a = 1056.748$ miles.	$d_a = 1056.35$ miles.
$11\ a = 2906.057$ "	$r - d_a = 2906.45$ "
$15\ a = 3962.805$ "	$r = 3962.8$ "
$19\ a = 5019.553$ "	$d_\beta = 5019.15$ "
$7\ a = 1849.309$ "	$r - 2\ d_a = 1850.10$ "

The coefficients of nodal division in the radius which is nearest the Moon, (4, 11), are the second and fourth of the secondary phyllotactic numbers. The coefficients in the remote radius, (8, 7), are the third phyllotactic numbers in the primary and secondary series, or the artiad and perissad divisors (Notes 201–2,). It may be interesting to inquire whether the frequency and locality of earthquakes are affected by these nodal influences.

249. *Pendulum Estimate of Earth's Oblateness.*

The ratio of Earth's equatorial semi-diameter to its theoretical equatorial pendulum, or the corresponding ratio of v_0^2 to v_r^2, (square of limiting orbital velocity to square of equatorial rotation-velocity), represents a centrifugal force which would tend to produce oblateness in a liquid globe, to maintain oblateness in a solidified globe, or to exert a constant pressure for restoring oblateness, should it be temporarily disturbed in any way. From the estimate of the theoretical pendulum in Note 246 we get

$$3962.8 : 1,142,882 : : 1 : 288.40$$

Bessels' estimate was 298.1528; Clarke's two estimates 291.36, 293.76; Listing's (1878, cited by Newcomb and Holden, p. 202), 288.5. This accordance furnishes additional reasons for believing that Earth's rotation and Moon's mean distance are as invariable as planetary major axes.

250. *Oscillatory Relations of Venus.*

The masses of Venus and Earth are more nearly alike than those of Jupiter and Saturn. This is perhaps owing to their comparatively central position in the belt of greatest condensation. The reasonable expectation that their mutual actions and reactions should be rhythmical is strengthened by many harmonic relations, among which are the following:

1. If we divide Venus's mean locus of subsidence (mean aphelion) by the product of the first four phyllotactic numbers, $1 \times 2 \times 3 \times 5 = 30$,

and call the quotient a, we obtain an approximate harmonic divisor for six cardinal nodes :

Harmonic.	Observed.
27 a .6740	Venus, s. p. .6722
28 a .6990	" m. p. .6978
29 a .7239	" m. .7233
30 a .7489	" m. a. .7489
31 a .7739	" s. a. .7744
40 a .9985	Earth, m. 1.0000

2. Venus's incipient locus of subsidence (secular aphelion) is near the second centre of linear oscillation of the incipient locus of subsidence of Mars.

$$(\tfrac{2}{3} \text{ of } \tfrac{3}{4} = \tfrac{1}{2}) \text{ of } 1.7365 = .7718.$$

Harmonic.	Observed.
.7718	.7744

3. The photodynamic origin of Venus's orbital period (224.701 days) is indicated by the proportion,

$$\rho_3 : l_\lambda : : t_e : t_v$$

The length (l_λ) of a theoretical pendulum at Sun's equator, which would oscillate once while a wave of light traverses the solar modulus of light, is $l_\lambda = 224.261\ \rho_3$; t_e and t_v are respectively Earth's day and Venus's year.

4. Moon's semi-axis major is a mean proportional between Earth's semi-diameter (r_3) and Venus's nearest approach to Earth. Venus's secular aphelion $= .7744234\ \rho_3$; Earth's secular perihelion $= .9322648\ \rho_3$; difference, $.1578414\ \rho_3 = 3695.725\ r_3$; $\sqrt{3695.725} = 60.792$.

5. Earth's oscillatory influence on Venus's mean subsidence is indicated by the proportion

$$r_3 : l_3 : : \rho_m : \rho_s$$
$$3962.8 : 1,142,882 : : 60.2778 : 17384.276$$

Stockwell's estimate for Venus's mean locus of subsidence is $.748878\ \rho_3 = 17534.36\ r_3$.

6. All the orbital loci of Venus are midway between Sun and orbital loci of Mars.

7. Venus's incipient rupturing locus (secular perihelion $= .672\rho_3$) is near Earth's linear centre of oscillation ($\frac{2}{3}$ of ρ_3.)

8. Venus's mass indicates Earth's harmonic influence at her incipient locus of subsidence (ρ_s).

$$m_3 : m_2 : : \rho_3 : \rho_s$$
$$428,417 : 331,776 : : 1 : .7744234$$

Hill's estimate for $m_0 \div m_2$ is 427,240, which differs from the harmonic estimate by less than $\frac{3}{10}$ of one per cent.

251. *Oscillatory Relations of Mercury.*

The cardinal loci of Mercury show the following among other harmonic relations:

1. The locus of Mercury's semi-axis major (.3871) is the rupturing locus for Venus's locus of incipient subsidence: ($\frac{1}{2}$ of .7744 = .3872).

2. Mercury's incipient rupturing locus (.2974) indicates phyllotactic influence at Venus's locus of incipient subsidence (.7744)

$$.2977 : .7741 :: 5 : 13.$$

3. Mercury's incipient rupturing locus (.2974) is also near the extremity of the linear pendulum, which has Mars's incipient subsidence locus (1.7365) for its point of suspension, and Venus's incipient subsidence locus (.7744) for its centre of oscillation:

$$(3 \times .7744 - 1.7365) \div 2 = .2934.$$

4. If we divide Earth's semi-axis major by the phyllotactic product $2 \times 3 \times 3 \times 13$, we find approximate indications of Earth's harmonic influence on Mercury's cardinal loci.

70 a	.298	Mercury s. p.	.297
75 a	.320	" m. p.	.319
91 a	.388	" m.	.387
107 a	.456	" m. a.	.455
112 a	.477	" s. a.	.477
234 a	.997	Earth	1.000

252. *Improbability of Accidental Harmonies.*

Schuster's harmonic investigation (Note 141) appears to have been grounded on the hypothesis, which others have also entertained, that harmonies such as are found in spectral lines and planetary positions may be accidental. In note 244, I spoke of such an hypothesis as "wrongly assumed," and I believe that it is only calculated to hinder scientific progress. Professor Peirce, in the Howland will case, showed that the relation of each individual position to all the possible positions which it might assume, as well as the relative positions of the lines among themselves, should be considered in calculations of mathematical probability. In the Iliad problem, the bare improbability of the accidental arrangement of the letters in their orderly sequence is a^n, a representing the number of letters in the alphabet and n the number of letters in the poem. Let p be the number of readily distinguishable positions which each letter can assume, and the adverse probability against the accidental occurrence of the actual positions would be $(ap)^n$. The improbability would be likewise increased by considerations of the spaces between the letters, the word spaces, the orderly arrangement of lines and pages, the probable frequency of errors, and countless other particulars which are indicative of plan and purpose. Finally, the adequate explanation which is furnished by the simple hypothesis of human contrivance, wholly removes the question from the realm of chance, and makes the improbability infinite.

PROC. AMER. PHILOS. SOC. XX. 112. 2z. PRINTED NOVMEBER 15, 1882.

253. *Probability of Anticipated Results.*

It is not likely that any one would ever think of attributing the angles of crystals to accident, although it would not be so unreasonable to do so as it would be to account for much closer harmonies in that way. The laws of crystallization are obscure and almost wholly unknown, and yet we are not slow in believing that there are such laws, in spite of the irregularities which were pointed out in Note 232. The laws of elasticity, which lead to nodal action, are as well understood as any of the fundamental truths of physical science, yet there are many who fail to recognize them, and who seem to think that no explanation is needed of the harmonies which thrust themselves upon us on every hand. I am not aware that any attempt has ever been made, by any one who believes in the possibility that connected harmonies may be merely accidental, to confirm his belief by framing a series of such harmonies. In ordinary investigations, the discovery of a single fact, through anticipations which are grounded upon theoretical assumptions, is hailed as a wonderful scientific achievement. In the study of rhythmic elasticity such successful anticipations may be endlessly multiplied before their importance becomes generally understood. And yet each one of those verified anticipations lends a confirmation to the photodynamic hypothesis which is little, if any, short of absolute certainty, and which cannot be measured by any ordinary test of mathematical probability.

254. *A Photodynamic "Problem of Three Bodies."*

We have now gathered, by strictly Baconian methods, all the facts which are needed for framing and solving the following problem: To find simple stellar, planetary and satellite relations of mass, position and æthereal density, that will satisfy tendencies to the formation of three primary harmonic nodes, in an elastic medium which propagates undulations with the velocity of light.

1. Nodal tendencies presuppose some deviations from absolute homogeneity, which lead to differences of direction and velocity in the subsiding particles, thus giving rise to oscillations which continually incline to take some form of synchronism. As long as there is any liberty of motion among the particles, those which are at the boundary line, between the constraining inertia of central stellar nucleation and æthereal impulse, will oscillate with the greatest rapidity, tending to assume paths which will alternately receive and exhaust the projectile energies of the æthereal medium. Those energies cannot be completely exhausted until enough time has elapsed to communicate the velocity of light (v_λ), to an æthereal particle which is at rest at the beginning of the oscillation. The central inertia makes the oscillations circular, changing free elliptic revolution into constrained axial rotation, each oscillation of half-rotation occupying a time (t) which gives $gt = v_\lambda$; $gt_2 =$ modulus of light $= M$; $M \div \pi^2 =$

length of a theoretical pendulum, at the stellar equatorial surface, which would swing synchronously with the rotary oscillations; $g = \frac{v_\lambda}{t} = \frac{m}{r^2}$. The value of g determines the mean orbital velocity, $\sqrt{gr_n}$, for any semi-axis major, r_n.

2. The actions and reactions, between the stellar centre and the primary centre of planetary condensation (Note 23), involve tendencies towards the linear centre of gravity ($\frac{1}{2}$), the centre of linear oscillation ($\frac{1}{3}$), the centre of conical oscillation, ($\frac{1}{4}$), and centripetal accelerations which vary as the fourth power of the velocity of circular orbital revolution. These tendencies may all be satisfied by a stellar mass which is $(2 \times 3 \times 4)^4 = 331{,}776$ times the mass of primary condensation.

3. The orbital control of the stellar centre is exercised on the planet and satellite alike, at the mean distance ρ_3. If the planet transfers to the satellite a projectile *vis viva*, (l), corresponding to its superficial energy of rotation (Note 246), the relative masses of the planet and satellite, which satisfy their joint oscillatory relations and Sun's projectile energy, may be represented by the proportion:

$$\rho_3 : l :: m_3 : \mu.$$

255. *Subordinate Tendencies.*

There are other harmonic tendencies which seem likely to have been less permanent and more open to modification. The following instances of primitive tendency may be given as interesting:

4. The radii of static equlibrium are inversely as the masses; rupturing *vis viva* is acquired by subsidence through $\frac{1}{2}$ radius; if the rupturing locus of simple subsidence becomes a centre of linear oscillation for satellite semi-axis major, ρ_μ, we have

$$\rho_\mu : r_3 :: \tfrac{3}{2} m_3 : 2\ \mu.$$

5. The relations of æthereal density are found by the method of Note 240.

Notes 162, 23, and 246 give the following mass values which *precisely* satisfy the first three of these requirements, viz: $m_0 = 331{,}776\ m_3$; $m_3 = 81.186\ \mu$. The fourth requirement points to the value, $m_3 = 80.372\ \mu$. This slight discrepancy may, perhaps, be partly owing to the fact that Earth's oscillation is mainly rotational while Moon's is nearly that of a circular pendulum.

256. *Other Approximations to Moon's Mass.*

a. The formula, $mt^2 \propto \rho^3$, gives the following approximations to the value of μ: (1 year ÷ 1 lunar mo.)$^2 = 178.724$; $(\rho_3 \div \rho_\mu)^3 = 58{,}609{,}000$; $(m_0 + m_3) = 327{,}930$ $(m_3 + \mu) = 331{,}777\ m_3$; $m_3 = 86.241\ \mu$.

b. A close harmonic approximation is given by the proportion:

$$m_3 : \mu :: 6\ t_3 : t_\mu :: 2191.54 \text{ dy} : 27.32166 \text{ dy} :: 80.214 : 1.$$

c. The coefficient of t_3, in the above approximation, is the phyllotactic product, $1 \times 2 \times 3$. It is also very nearly equivalent to the square root of the quotient of Laplace's solar limit by Sun's semi-diameter, which would give, $m_3 = 80.619\ \mu$.

d. The mass of Mars is very nearly a mean proportional between the masses of Earth and Moon; $(3{,}093{,}500 \div 331{,}776)^2 = 86.938$.

e. An approximation similar to *b* is given by the proportion:

$$\text{month} : \text{day} :: m_3 : 3\ \mu :: 81.965 : 3.$$

f. Moon's locus of subsidence, or aphelion (s), and the mass of Venus (m_2), furnish the following approximation:

$$m_2 : \mu :: s : r_3 :: 63.593 : 1.$$

Substituting the observed basis of the second approximation to m_2 in Note 250, this gives, $m_3 = 82.119\ \mu$.

Many other approximations might doubtless be found which would represent obvious harmonic tendencies within the belt of greatest condensation.

257. *Simplicity and Conciseness of Harmonic Calculus.*

The range of estimates in the foregoing note is about $8\frac{3}{8}$ per cent., and the mean of all the estimates is about 2 per cent. greater than the most recent astronomical estimates. These deviations are four times as great as in my extreme estimates of solar distance, and twelve times as great as in the estimates which have been based upon the latest determinations of the harmonic elements. If these approximations are compared with those which had been made by astronomers, a hundred years after Newton had published the laws of gravitation, the indications of superiority in the harmonic methods become very striking. The difficulty of finding the harmonic influences which are most important, is incomparably less than that of determining the corresponding gravitating influences, and the saving of labor is obvious to every one who has ever solved astronomical problems by the ordinary processes of mathematical analysis. Doubts as to the degree of certainty which attaches to purely harmonic results will naturally arise, in the minds of those who have never carefully inquired into the necessity of elastic rhythm, but I believe that such doubts will gradually yield to the fast accumulating evidences of its universal sway. Astronomical, chemical and mechanical science may all be challenged to produce a series of connected fundamental determinations that are comparable, in precision and in intrinsic mathematical probability, with those which are embodied in Note 168 and in the three solutions of Note 254.

258. *Needless Obscurity.*

In Sir John Leslie's Dissertation on the Progress of Mathematical and Physical Science (*Encyc. Brit.*, 8th. Ed., i, 732), after referring to the "maze of intricate and abstruse *formulæ*" in which Laplace had involved the phenomena of capillary attraction, the following reflections of Dr.

Thomas Young are quoted :—"It must be confessed that, in this country, the cultivation of the higher branches of the Mathematics, and the invention of new methods of calculation, cannot be too much recommended to the generality of those who apply themselves to Natural Philosophy ; but it is equally true, on the other hand, that the first mathematicians on the Continent have exerted great ingenuity in involving the plainest truths of mechanics in the intricacies of Algebraical formulas, and in some instances have even lost sight of the real state of an investigation, by attending only to the symbols, which they have employed for expressing its steps." After this quotation Leslie proceeds as follows :—"Laplace's intricate formula has been since unraveled by the acute discrimination of Mr. Ivory, who disjoined it into two separate portions ; the one depending on the adhesion of the watery film to the inside of the tube, and the other resulting from halt the cohesion of the particles of the liquid to each other. But our ingenious countryman deduced these elements of the complete force from the simplest physical principles, availing himself of the property of equable diffusion of pressure through the mass of a fluid. The same investigation gave the measure and limits of depression observed in mercury and some other liquids."

259. *Coöperative Methods.*

Since the invention of Hamilton's quaternions and Peirce's linear associative algebras, the temptation for mathematicians to involve "the plainest truths of mechanics in the intricacies of algebraical formulas" has greatly increased. The higher the algebra, the smaller is the number who are able to understand it. While it may be no part of an investigator's duty to "popularize" science, no result can be rightly regarded as belonging to the dominion of science until it has been so far popularized as to be brought within the grasp of the majority of scientific men who are willing to follow the several steps of the original investigation. Labor which is expended on intricate solutions of problems which can be simply deduced from "the property of equable diffusion of pressure through the mass of a fluid," or from other properties of elastic media, is either labor wholly wasted, or, at best, an exercise of ingenuity which serves as a harmless recreation. On the other hand, the use of well-known physical relations as clews for the discovery of coördinate relations, alternating with analytical solutions of problems which are suggested by such discoveries, combines the advantages of theory and observation in ways which are most helpful to scientific progress. Whenever any given result may be reached by two or more different methods, the shortest and simplest is always most commendable.

260. *Lunar Magnetic Polarization.*

The relations between magnetic fluctuations and gravitating tendencies to the restoration of equilibrium in disturbed atmospheric or æthereal currents

(Notes 116–122), are, as might reasonably have been foreseen, greatly modified by Sun's thermal activity. The moon, acting on the currents which originate in Sun's thermal disturbance, shows accordances both in time and magnitude (Note 121), which point strongly, if not conclusively, to an absolute identity between lunar disturbances of terrestrial magnetism and of terrestrial gravitation. These pointings are confirmed by the identity of velocity, in the electro-magnetic "ratio," in the pendulum-oscillations of solar rotation, and in the transmission of luminous undulations. The symmetrical arrangement of æthereal particles which most simply represents the results of elastic pressure (*Proc. Amer. Phil. Soc.*, xii, 408), the spiral tendencies of division in extreme and mean ratio, the rotation which helps to maintain equilibrium between conflicting forces (Note 212), the differences of centrifugal and centripetal energy which result from rotation, all contribute towards an axial polarity which should modify all forms of chemical and mechanical aggregation. To these elements of cyclical rhythm Moon adds her orbital disturbance of Earth's rotation (Notes 247–8), which is so modified by orbital inclination as to produce a magnetic nutation. If we add to these considerations the oscillations of Earth's crust, and other influences which lead to variations in the relative positions of areas of greatest heat and cold, we find data for many interesting problems in mathematical analysis, the solution of which may throw much light both on the normal and abnormal phenomena of terrestrial magnetism.

261. *Gravitating Modulus of Planetary Revolution.*

The hypothesis that stellar rotation is merely retarded revolution, and the exact correspondence between the time of rotary oscillation and the time in which maximum gravitating acceleration would communicate the velocity of light to an æthereal particle, suggest the likelihood of other moduli, which may be intimately connected with the solar-equatorial modulus of light, and which may help us towards a fuller understanding of fundamental kinetic relations. As the rotary oscillations are circular, the simplest and most natural comparison would refer them to circular revolutions of uniform velocity; as all orbital times and velocities are functions of mass and distance, it seems right to begin by examining the greatest possible limit of circular-orbital velocity ($\sqrt{g_o r_o}$), and the least possible limit of circular-orbital oscillatory time $\left(\frac{1}{2}t \text{ of revolution} = \pi\sqrt{\frac{r_o}{g_o}}\right)$. The British Nautical Almanac value of n, Note 75, gives $t = \frac{1}{2}\, t_o = 5024.5$ sec.; $g_o\, t = \pi\sqrt{g_o\, r_o} = .0019643\ r_o$; $g_o\, t^2 = \pi^2\, l = \pi^2\, r_o$. The photodynamic relations of this fundamental gravitating modulus, to the two chief planetary loci, are shown by the approximate identity of t with the time in which a luminous ray would traverse Jupiter's orbit or Saturn's mean aphelion radius vector. Neptune's gravitating modulus, $\pi^2\, \rho_8$, represents

the second supra-Neptunian locus which I indicated in 1873, and which Forbes found to represent a group of cometary aphelion distances (Note 32).

262. *Photodynamic Modulus of Planetary Revolution.*

A mathematical friend, in whose judgment I place great confidence, admits the conclusiveness of the evidence in favor of paraboloidal harmony in rupturing planetary loci (Note 46, etc.), but he thinks that the approximation to the locus of *Alpha Centauri* may be accidental. I am well aware of the difficulty, which every one naturally finds, in believing that the seemingly quiet undulations of light should have any influence on the relative positions of stellar systems. The remembrance that the *vis viva* of action or reaction, for any given mass, varies as the square of oscillating velocity, would show that if there is any physical influence which controls interstellar arrangements, it should be the one which has the greatest normal velocity. The parabolic energy which is manifested within the solar system, both in approaching and in leaving the sun, must be indefinitely extended, and the luminous undulations which it indicates are equally extensive. The symmetry of the three-fold division in the paraboloid, together with the fact that the uncertainty of stellar distance is of the same order of magnitude as planetary eccentricities, excludes any probable attribution of the stellar accordance to accidental coincidence. The foregoing note furnishes additional grounds for accepting all the harmonic relations of the photodynamic paraboloid as effective. Since $L_o \propto r^2$ (Note 75), and L_o at $r_o = \pi^2 l_o^3$, at the gravitating modulus $\pi^2 r_o$, the photodynamic modulus would be $\pi^6 l^3{}_o$, its logarithm being $6 \times .4971499 + 3 \times 1.5606934 = 7.6649796$. This is only .0013506 less than the logarithm for the locus of *α Centauri*, as deduced from the corona line and the British estimate of Sun's semi-diameter, indicating a difference of less than $\frac{5}{1000}$ of one per cent. It is, therefore, *certain* that the photodynamic modulus of Sun's gravitating modulus is in the *neighborhood*, if not in the actual locus, of the nearest known star.

263. *A Chain of Photodynamic Harmonics.*

If we designate the planetary locus which corresponds to the corona line (Note 45) by x; Jupiter's greatest eccentricity by y; and the theoretical locus of *α Centauri* by z, the following connected equations can all be deduced from simple and obvious forms of elastic rhythm :

1.	$y = 1 - (1048.875 \div 5.202798\ n) = .06055$	Note 3
2.	$m_o = (2 \times 3 \times 4)^4\ m_3 = 331776\ m_3$	" 23
3.	$x = \pi^{\frac{2}{3}}\ nr_o = 460.61\ r_o$	" 45
4.	$z : x :: m_3^{-2} : m_3^{-2} \quad z = 461746300\ r_o$	" 46
5.	$v_o = 2\pi\ r_o\ n^{\frac{3}{2}} \div 1\ \text{year} = .0006265013\ r_o$	" 75
6.	$V_o = \pi\ v_o\ (l_o \div r_o)^{\frac{3}{2}} = .4313442\ r_o$	" 75
7.	$V_o = nr_o \div 497.827 \quad n = 214.735$	" 75

8.	$z = \pi^6 l_o^3 \div r_o^2 \quad l_o = 36.3497\ r_o$	Note 261
9.	$r_a = r \div n = 960''.556$	" 75
10.	$r_o = (m_o \div m_3)^{\frac{1}{3}} \times (1\text{ yr.} \div t_3)^{\frac{2}{3}} \times r_3 \div n = 432094$ miles	" 75
11.	$p_o = r_3\, r_a \div r_o = 8''.8094$	" 75
12.	$t_o = 1\text{ yr.} \div n^{\frac{3}{2}} = 10029$ sec.	" 75
13.	$d_o \div d_3 = (t_3 \div t_o)^2 = .255927$	" 75
14.	$L_o = (V_o \div v_o)^2\, r_o = 474028\ r_o$	" 75
15.	Corona line $= 7612 \times \log. 30.037\ n \div \log. x = 5321.7$	" 45
16.	$\rho_3 = nr_o = 92{,}785{,}700$ miles	" 75

The values of y, m_o, x, z, l_o, L_o, and the corona line, all represent photodynamic considerations; the other values are readily deduced from them by simple radiodynamic relations. Stockwell's estimate of y is .06083; the value of n is intermediate between those of the British and the American Nautical Almanacs; the value of the corona line corresponds *precisely* with the geometrical wave-length in Note 41; all the other values are within the astronomical limits of probable error.

264. *Further Oscillatory Relations of Venus.*

It seems not unlikely that the position of Venus, in the belt of greatest condensation, may have nearly as many suggestive relations as that of Earth. To the eight indications of Note 250, the following may be added:

9. All the orbital loci of Venus are between a primary and a secondary centre of linear oscillation for Earth's semi-axis major ($\frac{2}{3}$, and $\frac{2}{3} + \frac{1}{3}$ of $\frac{1}{3} = \frac{7}{9}$). Stockwell's estimates are, secular perihelion, .6722; secular aphelion, .7744.

10. The secular aphelion of Venus is nearly a mean proportional between Earth's second reciprocal centre of oscillation ($\frac{1}{3}$ of $\frac{1}{3}$), and Jupiter's secular aphelion; $\sqrt{\frac{1}{9} \times 5.42735} = .7766$.

11. The major-axis of the nebular ellipse which marks the incipient separation of Venus from Earth, 1.7744, is indicative of a successive nucleation for Earth's semi-axis major; $\frac{4}{3} \times \frac{4}{3} = 1.7778$.

12. The mass harmony (8), introduces the principle of virtual velocities into the foregoing nebular ellipse, at the beginning of subsidence for Venus.

265. *Tidal Harmony.*

The tidal disturbance of Earth by Sun, during a semi-annual orbital oscillation, is sufficient to give orbital velocity to all the particles which are disturbed both by Sun and by Moon. Orbital velocity would be communicated in $\frac{1}{\pi}$ of an oscillation, to the particles which are disturbed by Sun's tidal action. During the remainder of the oscillation a like velocity would be communicated to $\pi - 1$ times as many particles. If we desig-

nate Moon's mass and semi-axis major by m_a and ρ_a, this approximation gives us the following proportion :

$$m_a : \rho_a^3 : : (\pi - 1)\, m_\circ : \rho_3^3.$$

Substituting $m_\circ = 331776\ m_3$, $\rho_3 = 92785700$ miles, $\rho_a = 238869$ miles, we get, $m_3 = 82.486\ m_a$. The values which were found in Notes 8 and 246 seem likely to be subject to fewer modifications than this, but every additional indication of approximation to anticipated harmonies lends new interest to the discussion of elastic influence and furnishes new material for future analytic research.

266. *Harmonic Tidal Cycles.*

The tendency of the solar and lunar tidal disturbances to cyclic harmony, is shown by the approximate equality of the solar disturbance, during the interval which would give terrestrial particles orbital velocity, to the lunar disturbance, during a sidereal revolution about the Earth. The approximation may be expressed by the equation :

$$\frac{m_\circ}{\rho_3^3} \times \frac{1\ yr}{2\pi} \doteq \frac{m_a}{\rho_a^3} \times 1\ mo.$$

Substituting the same values as in the foregoing note for $m_\circ$, ρ_3 and ρ_a, we get the approximate value, $m_3 = 83.025 m_a$. The closeness of these various approximations may be attributed, with great likelihood, to original influences of central-belt condensation, aided by the natural stability of harmonic oscillations which have once been set up. The slight discrepancies between different estimates are probably owing to subordinate rhythmic disturbances, such as nutation, precession, and other oscillations, the exact influence of which we may reasonably hope to understand when we have a fuller knowledge of æthereal elasticity.

267. *Subterranean Tides.*

My views regarding the influence of elasticity upon tidal adjustments, (*Proc. Amer. Ph. Soc.*, ix–xiv ; xvi, sq.; *Phot. Notes* 215–8), are confirmed by the subterranean tides in the flooded mines at Dux, in Bohemia. In a communication to *Ciel et Terre* (copied in *Ann. de Chim. et de Phys.*, xxv, 533–46), M. C. Lagrange cites the discussion, by Grablowitz (*Boll. della Soc. Adr. di Sci. Nat. in Trieste*, vol. vi, fasc. I, 1880), of Klönne's observations. The observations seem to show conclusively that the ebb and flow in the mines is due to combined solar and lunar action, but that it can be satisfactorily explained only by the direct attraction of the two bodies upon the solid mass of the Earth. Lagrange refers to previous investigations, by himself and by George H. Darwin, which go to show that if cosmical bodies have any elasticity, they must undergo continual and periodic changes of form. Grablowitz infers that those changes should lead to oscillations of various intensity, so as to produce mechanical effects which differ according to the nature and degree of local elasticity,

but subjected to invariable laws which are regulated by the relative movements of the disturbing bodies. Naumann's tables (*Handbuch der Chemie*, 1877, pp. 346–59), show that if the whole Earth was a solid diamond, or if it was composed of rocks which are least expansible, the greatest quarter-daily tidal deformations would not involve an amount of work equivalent to $\frac{1}{2}^{\circ}$ C. The spring tidal stress during six hours is $\left(\frac{m_o}{\rho_3^{\,3}} + \frac{m_a}{\rho_a^{\,3}}\right)\frac{gt^2}{2} \doteq 619$ ft., which is enough to furnish many times the available force requisite for all the adjustments of æthereal elasticity, freely moving particles, and internal work in the solid rocks.

268. *"Conservation of Solar Energy."*

The views of Dr. C. William Siemens suggest a consideration of the influence of solar rotation upon the æthereal atmosphere, at various distances from Sun's centre. Laplace's limit, according to the data in Note 263, is at 36.35 r_o. The centrifugal force of rotation at that limit would be $36.35^2 = 1321.3$ times as great as at Sun's surface, while the centripetal force of gavitation is only $\frac{1}{1321.3}$ times as great. The photographs of the solar eclipse which have been lately published (*Nature*, April 20th, 1882), indicate an atmospheric oblateness which may be due to the equilibrating tendencies of these two opposing forces. If the æthereal disturbances which result from this source are not sufficient to account for luminous and thermal vibrations, we may look still further to the velocity which the subsiding particles would acquire in falling from the equatorial limit to the poles. If there was no resistance, this velocity would be $\left(\frac{35.35}{36.35} \times 2gr\right)^{\frac{1}{2}} = 376.8$ miles per second. Any diminution of this velocity by resistance would be converted into heat. If the mean limit between the centrifugal and centripetal tendencies is in latitude 30°, the mean diminution of velocity when the particles reach the polar zone, would be .982 of 376.8 = 370 miles. If the mean time of accomplishing the centrifugal and centripetal cycles is the same as the time of half-rotary oscillation, the formula of torsional elasticity (Note 162) provides for radiations with the oscillatory velocity of light, and the general tendency of nebulæ to a discoid or flattened form gains a new significance.

269. *Another Test of Atomic Divisors.*

In order to avoid all questions of absolute probability, in Notes 171, 201, 202, etc., I have computed $(n\,\mathrm{D} - \mathrm{O}) \div \mathrm{D}$ for all the elements in Clarke's table except H, using $\mathrm{D}_1 = 7$ for the perissads, $\mathrm{D}_2 = 8$ for the artiads, $\mathrm{D}_3 = 1$ for the hydrogen divisor. Adding the logarithms of $(n\,\mathrm{D} - \mathrm{O}) \div \mathrm{D}$, I find for the perissads,

Σ (for D_1) = A	$\overline{2}\,0.4692966$
Σ (for D_3) = B	$\overline{2}\,2.9326580$
A — B	1.5366386

The aggregate probability of the hydrogen divisor is, therefore, 34.406 times as great as that of the general perissad divisor, 7.

For the artiads

Σ (for D_2) = C	$\overline{4}\,5.3906748$
Σ (for D_3) = D	$\overline{3}\,8.1502848$
D — C	6.7596100

The aggregate probability of the general artiad divisor, 8, is therefore 5749234 times as great as that of the hydrogen divisor.

For all the elements,

Σ (for D_1 and D_2) = E	$\overline{6}\,5.8599714$
Σ (for D_3) = F	$\overline{5}\,9.0829428$
F — E	5.2229714

The aggregate probability of the atmospheric divisors is, therefore, 167098 times as great as that of the hydrogen divisor.

Dividing the sums of the perissad, artiad and total logarithms by 20, 44, 64, respectively, we get for the mean values of $(n\,D - O) \div D$, and for the mean relative probability of phyllotactic influence,

		Log.	Antilog.	Probability.
Perissad,	D_1	$\overline{1}.0234648$	.10555	2.145
	D_3	$\overline{2}.9466329$	.08844	3.223
Artiad,	D_2	$\overline{2}.9861517$	.09686	2.124
	D_3	$\overline{1}.1397792$	.13797	1.491
Total,	D_1, D_2	$\overline{2}.9978121$	.09950	2.009
	D_3	$\overline{1}.0794210$	.12007	1.664

The relative probability is found by dividing the mean accidental ratios for 20, 44, and 64 numbers, with differences equally distributed, by the antilogarithms, or observed ratios. The accidental ratios are .22607 for the perissads, .20578 for the artiads, .19985 for the whole list of elements.

Some criticisms have been made upon my previous estimates of probability, which overlooked my demonstration that ordinary tests fail to show probabilities which are known to exist (Notes 145, 149), and my introduction of "the *a priori* probability of tendency to division in extreme and mean ratio" (Note 171). As my object is to show the *relative* probability of different divisors, and as it is impossible to know what weight should be given to *a priori* considerations, the present method may be acceptable.

270. *Fundamental Centrifugal and Centripetal Mass-Relations.*

The influence of cardinal loci upon the relative masses at the chief centre of nucleation and at the chief centre of condensation, is shown by the equation:

$$\frac{m_3}{m_0}\cdot\frac{l^4}{r_0^4} = \frac{\rho_5}{\rho_3}. \qquad (1)$$

In this equation, ρ_3 = Earth's semi-axis major = 1; ρ_5 = Jupiter's semi-axis major = 5.202798; r_0 = Sun's semi-diameter; l = Laplace's solar limit = 36.3658 r_0 (See Note 75). This gives for Sun's mass, m_0 =

336,153 m_3, which is 1.32 per cent. greater than the estimate which is based on requirements of oscillation and subsidence (Notes 5, 23, etc.). If f_o, f_1 designate the centrifugal force of rotation at r_o, l, respectively, and g_o, g_1 represent the corresponding centripetal accelerations of gravity, equation (1) may assume the form:

$$\frac{m_3}{m_o}\cdot\frac{f_1}{g_1}=\frac{\rho_3}{\rho_3}\cdot\frac{f_o}{g_o} \qquad (2)$$

Equation (1) is especially interesting for its bearing on the conservation of solar energy (Note 268); equations (1) and (2) represent the equal ratios of action and reaction between centripetal and centrifugal tendencies, all the numerators having a centrifugal origin, while all the denominators are centripetal. Combining these equations with the equation of Earth's photodynamic *vis viva* (Note 91), we get

$$\frac{m_3}{m_3}\cdot\frac{l^4}{r^4}=\left(\frac{v_\lambda}{v_n}\right)^2\cdot\frac{\rho_3}{\rho_3} \qquad (3)$$

Here also we have centrifugal numerators and centripetal denominators, together with photodynamic orbital relations of mass, distance, velocity, rotation, revolution and condensation, which are very suggestive.

271. *Perissad Relations of Nitrogen.*

If we take the continued product, for all the elements, of the percentages of D which represent $(n\ \mathrm{D}-\mathrm{O})\div\mathrm{D}$, the hydrogen product is 69.208 times as great as for Gerber's empirical divisors, and 18178.47 times as great as that for my phyllotactic factors (Note 136). While this is sufficient to show the influence of phyllotactic tendencies, my comparisons of relative probability have led me to the discovery of important modifications of these tendencies by the abundant gases, H, N, O; H being a representative factor of the monatomic elements, $\frac{1}{5}$ N for the tri- and pentavalent, 8 H for the di- and tetratomic, $\frac{1}{16}$ O = .998 for the remaining metallic elements. The effect of a slight difference in the divisor upon the residuals, as well as my method of operation, may be illustrated by testing Gerber's divisor ($D_1 = 1.559$) and my own ($D_2 = \frac{1}{5}$ N = 1.558) on the tri- and pentavalent elements:

	Clarke.	R_1.	R_2.	Log. R_1.	Log. R_2.
N	14.021 = 9 D_1 − 10 = 9 D_2 −	1	1.0000000	.0000000
P	30.958 = 20 D_1 − 222 = 20 D_2 −	202	2.3463530	2.3053514
As	74.918 = 48 D_1 + 86 = 48 D_2 +	134	1.9344984	2.1271048
Sb	119.955 = 77 D_1 − 88 = 77 D_2 −	11	1.9444827	1.0413927
Bi	207.523 = 133 D_1 + 176 = 133 D_2 +	309	2.2455127	2.4899585
Au	196.155 = 126 D_1 − 279 = 126 D_2 −	153	2.4456042	2.1846914
Bo	10.941 = 7 D_1 + 28 = 7 D_2 +	35	1.4471580	1.5440680
Ta	182.144 = 117 D_1 − 259 = 117 D_2 −	142	2.4132998	2.1522883
V	51.256 = 33 D_1 − 191 = 33 D_2 −	158	2.2810334	2.1986571
Σ log. R			18.0579422	16.0435122
9 × log. D			28.7356149	28.7331075
Σ log. (R ÷ D) = log. P			$\overline{11}$.3223273	$\overline{13}$.3104047
Mean log. = $\frac{1}{9}\Sigma$ log. = log. p			$\overline{2}$.8135919	$\overline{2}$.5900450

The logarithm of aggregate relative probability is $\overline{11}.3223273 - \overline{13}.3104047 = 2.0119226$; the log. of mean relative probability is $\overline{2}.8135919 - \overline{2}.5900450 = .2235469$. Hence the aggregate relative probability of the nitrogen divisor, $P_2 \div P_1 = 102.783$; the mean relative probability, $p_2 \div p_1 = 1.6732$.

272. *Aggregate and Mean Ratio of Residuals to Atomic Divisors.*

In the following table the logarithms for each group are computed after the method of the foregoing note. The divisor for the first surd, S_1, is $\frac{1}{2}(3-\sqrt{5}) = .382$; for the second surd, S_2, $\frac{1}{2}(\sqrt{5}-1) = .618$; for hydrogen, $H = 1$; for Gerber and Chase I, see Note 136; for Chase II, see Note 269; for Chase III, see Note 271.

Group.	S_2.	S_1.	H.	Gerber.	Chase I.	Chase II.	Chase III.
Monat.	$\overline{8}.3393239$	$\overline{8}.5143370$	$\overline{12}.2138579$	$\overline{11}.7186094$	$\overline{11}.6283038$	$\overline{11}.4619386$	$\overline{12}.2138579$
3 and 5.	$\overline{7}.4310096$	$\overline{8}.7210766$	$\overline{10}.7187995$	$\overline{11}.3223273$	$\overline{11}.3223273$	$\overline{9}.0673580$	$\overline{13}.3104047$
2 and 4.	$\overline{11}.7492826$	$\overline{14}.6963491$	$\overline{16}.5909435$	$\overline{23}.8649303$	$\overline{23}.6476134$	$\overline{23}.3406987$	$\overline{23}.3406987$
Metal.	$\overline{18}.5073145$	$\overline{19}.1410255$	$\overline{23}.5593397$	$\overline{18}.3369171$	$\overline{20}.2251388$	$\overline{22}.0499751$	$\overline{22}.5388218$
Periss.	$\overline{15}.7703335$	$\overline{15}.2354136$	$\overline{23}.9326574$	$\overline{21}.0409367$	$\overline{22}.9506311$	$\overline{20}.4692966$	$\overline{25}.5242626$
Artiad.	$\overline{23}.2565971$	$\overline{23}.8373746$	$\overline{35}.1502832$	$\overline{40}.2018474$	$\overline{43}.8727522$	$\overline{45}.3906738$	$\overline{55}.8795205$
Aggreg.	$\overline{42}.0269306$	$\overline{47}.0727882$	$\overline{59}.0829406$	$\overline{61}.2427841$	$\overline{64}.8233833$	$\overline{65}.8599704$	$\overline{79}.4037831$
Mean.	$\overline{1}.3441708$	$\overline{1}.2667623$	$\overline{1}.0794209$	$\overline{1}.0506685$	$\overline{1}.0128654$	$\overline{2}.9978120$	$\overline{2}.7719341$
Rel. Ag.	.0000000	4.9541424	16.9439900	18.7841465	21.2035473	22.1669602	36.6231475
Rel. M.	.0000000	.0774085	.2647499	.2935023	.3313054	.3463588	.5722367

The aggregate residual ratio for S_2 is more than 87,900,000,000,000,000 times as great as for hydrogen, and more than 4,199,000,000,000,000,000,000,000,000,000,000,000,000 times as great as for the relations to H, N, O; the mean ratio is 1.8397 times as great as for H, and 3.7345 times as great as for my second group of divisors. The aggregate hydrogen ratio is more than 47,770,000,000,000,000,000,000 times as great as for my third group, the mean ratio being 2.0299 times as great.

273. *Comparison of Geometric and Arithmetic Residual Means.*

The logarithms of the geometric mean residual ratios, for the several groups, may be found by dividing the monatomic logarithms by 11, the tri- and pentatomic by 9, the di- and tetratomic by 17, the metallic by 27. Some questions of relative probability may be tested more readily by arithmetical means, and for this reason as well as in order to preserve additional evidence of phyllotactic influence, the following table is given. All of my divisors were deduced from phyllotactic considerations; the first set shows the great superiority of my phyllotactic over Gerber's approximately phyllotactic divisors; the second set introduces corresponding terms of two phyllotactic series; the third set has two divisors which are simply phyllotactic (1, 8) and two which are products of phyllotactic ratios ($\frac{1}{16} = \frac{1}{2} \times \frac{1}{8}$; $\frac{1}{9} = \frac{1}{3} \times \frac{1}{3}$).

	Arithmetical.							Geometrical.						
Group.	S_2.	S_1.	H.	G.	C_1.	C_2.	C_3.	S_2.	S_1.	H.	G.	C_1.	C_2.	C_3.
Monat.	.237	.232	.215	.195	.171	.205	.215	.201	.209	.085	.116	.114	.109	.085
3 and 5.	.218	.225	.142	.096	.096	.186	.082	.186	.155	.093	.065	.065	.102	.039
2 and 4.	.288	.221	.214	.144	.145	.137	.137	.249	.165	.124	.050	.048	.046	.046
Metal.	.268	.259	.225	.246	.240	.227	.127	.225	.200	.148	.222	.185	.154	.068
Periss.	.229	.228	.182	.150	.137	.172	.155	.194	.183	.088	.090	.089	.106	.060
Artiad.	.276	.245	.220	.207	.203	.192	.131	.234	.186	.138	.125	.110	.097	.059
Aggreg.	.261	.240	.209	.189	.183	.186	.139	.237	.185	.120	.112	.103	.099	.059

274. *Some Consequences of the Identity of Luminous and Gravitating Oscillation.*

The æthereal particles, which are repelled from Sun's equator by the centrifugal force of rotation, "subside" spirally towards the poles, giving rise to Ampérian currents which account for Maxwell's identification of luminous and electromagnetic waves and yielding a mechanical equivalent of 76,000,000 J for every pound of subsiding matter; the axial core of the spirals is the rod of the virtual solar pendulum (Note 162) of which the length and the radius of torsion are both determined by the solar modulus of light; the continual succession of spiral impulsions substitutes uniform rotation for reciprocal oscillation; the *precise* accordance between the time of rotary oscillation and the time of acquiring or losing the velocity of luminous projection, shows the equally precise agreement between centrifugal æthereal action and centripetal gravitating reaction; the combination of axial rotation with orbital revolution produces continual shiftings of inertial resistance which must be followed by continual renewals of æthereal disturbance; the perpetual maintenance of luminous oscillation by influx, as well as by an equivalent efflux, removes "the reproach of Thermodynamics."

Such are a few of the obvious considerations which are suggested by the identity of luminous and gravitating oscillatory velocity at the centre of the solar system. In subjecting them to the tests of mathematical analysis, the equilibrating tendencies of centrifugal and centripetal action should be studied with especial reference to three oblate spheroids, all of which have the same poles as the Sun. Their equatorial loci are respectively coincident with Laplace's limit ($36.35r_\odot$), the virtual radius of solar torsion ($688.95r_\odot$), and the solar modulus of light ($474657r_\odot$).

275. *Consideration of Some Objections.*

Professor Geo. Fras. FitzGerald (*Nature*, xxvi, 80) presents four questions in the way of objection to the hypothesis of the conservation of solar energy by an average influx which is exactly equivalent to the average efflux. The reply of Dr. Siemens may be supplemented by some additional considerations. "1. How the interplanetary gases near the Sun acquire a sufficient radial velocity to prevent their becoming a dense atmosphere around him?" The proportionality of centrifugal force to mass would combine with the tendencies of gaseous diffusion and with the in-

creased molecular velocity of gaseous condensation, to maintain a constant circulation of all the constituents of the solar atmosphere. "2. Why enormous atmospheres have not long ago become attached to the planets, notably to the Moon?" The reported discovery of a lunar atmosphere by Trépied and Thollon, during the late solar eclipse, which is announced in the same number as the question, gives an apt and timely confirmation of Wollaston's views, which are cited by Siemens. "3. Why the earth has not long ago been deluged when a constant stream of aqueous vapor that would produce a rain of more than 30 inches per annum all over the earth, must annually pass out past the earth in order to supply fuel to be dissociated by the heat that annually passes the earth?" The average annual rainfall of the whole globe is not accurately known, but there is good reason to believe that it is very nearly, if not precisely, such as would be required by the hypothesis. "4. Why we can see the stars although most of the solar radiations are absorbed within some reasonable distance of the Sun?" The prevalent thermodynamic hypotheses suppose an unlimited power of absorbing radiant *vis viva*, without any tangible evidence of such absorption. All that needs to be explained is the maintenance of a uniform amount of æthereal oscillations in the universe. If the centrifugal and centripetal alternations of less elastic particles are linked with like alternations of more elastic particles, the actions and reactions of elasticity and inertia may account for the operation and stability of all physical laws.

276. *Influence of Explosive Oscillations on Radiant Energy.*

The relations which I have pointed out between explosive oscillations and planetary positions (*Proc. Amer. Phil. Soc.*, xii, 392–417, *et seq.*), should also influence the centrifugal and centripetal alternations within Sun's photosphere. I have often shown that the photodynamic equality of luminous and gravitating oscillations tends to drive all of Sun's particles towards the limit between aggregation and dissociation, so that a slight external disturbance may turn the unstable equilibrium in either direction. Berthelot's investigations (C. R. xciii. 613–9) of explosions in gaseous compounds by detonating agents, have indicated the existence of explosive waves which are quite distinct from simple waves of sound, and have shown that compounds and explosive mixtures generally become more sensitive to shocks as they near the temperature at which they begin to decompose. Hence a meteor, or even a single molecule, which has acquired a sufficient velocity of subsidence in its sunward fall, may explode a gaseous compound which is in or near the nascent state, and the explosion may react upon the falling mass or molecule so as to leave it in an unstable equilibrium which is ready for explosion by the next like subsidence. The locus of the virtual radius of solar torsion (ar_o, Note 162) in the asteroidal belt, makes the minor planets important outposts of explosive oscillation in the second of the oblate spheroids to which I called atten-

tion in Note 274, and opens a wide field for analytical research respecting the equilibrating tendencies between centripetal and centrifugal energy. The stability of major axes, in orbital revolution, is no more necessary than the reciprocal equality of radiodynamic action and reaction in elastic media.

277. *Relations of Earth to the Asteroids.*

Different portions of the asteroidal belt are so related to Earth's varying positions as to share the influence, either directly or through the conversion of oscillatory *vis viva* into projectile *vis viva*, of linear, spherical and explosive centres of oscillation. One of these relations, which seems specially important and significant in connection with the maintenance of solar energy, is found by dividing the virtual radius of solar torsion ($ar_o = 688.95r_o$) by Earth's mean radius vector ($\rho_3 = 214.45r_o$). This gives a relative distance of $1 \div 3.2134$, and a relative orbital velocity of $(3.2134 \div 1)^{\frac{1}{2}} = 1.7926 \div 1$ at the chief centre of condensation in the solar system, as compared with the orbital velocity at the extremity of the radius of torsion. This is within about $\frac{5}{1^{\frac{1}{2}}}$ of one per cent. of the ratio (1.8) of the *vis viva* of oscillating particles to the *vis viva* of wave propagation, which was indicated by me in 1872 (*Proc. Am. Phil. Soc.*, xii, 394), and by Maxwell in 1877 (*Phil. Mag.* [5] iii., 453, iv. 209). A portion of this trifling difference may be explained by the gradual diminution of æthereal density upon receding from stellar centres (Note 240).

278. *Collateral Hypotheses.*

In investigating the relations of centripetal and centrifugal action and reaction, it seems desirable to consider and compare the following hypotheses and conclusions:

1. Laplace's estimate that the velocity of transmission, in gravitating acceleration, is at least 100,000,000 times as great as that of light.

2. LeSage's hypothesis that gravitation and luminous undulation represent equal actions and reactions.

3. Faraday's fruitless search for a gravitating constant which would satisfy his interpretation of the doctrine of conservation of energy.

4. Herschel's comparison of the mean *vis viva* of light, with that of sound.

5. Weber's identification of the velocity of light (v_λ), with the "electromagnetic ratio" (v_ε).

6. Berthelot's "explosive waves," and their action upon sound waves.

7. The inquiries of Siemens into the combined influence of rotation, centrifugal action, gravitating force, and chemical affinity.

8. The various attempts of Thomson, Rankine, Maxwell, Eddy, and others, to escape the apparent consequences of the second law of thermodynamics.

279. *Cosmical and Molecular Constant.*

If there is a natural unit of force we may look for a natural unit of velocity. The hypothesis that all the particles of bodies are in constant motion, involves oscillation of various kinds, orbital, pendulous, or wave. Different transformations of similar oscillations are harmonic. Rotation may be regarded as a pendulous oscillation due to retarded and modified revolution. The resemblance of LeSage's theory to the kinetic theory of gases points to a probability that the natural unit of velocity is oscillatory. This probability is strengthened if we assume the existence of molecular and intermolecular elasticity. In looking to the activities of the principal mass in our system for indications of a natural unit of velocity, we find that gravitating velocities may be represented by gt. In order that gt may be constant, t must vary inversely as g and, therefore, directly as r^2. This variation is found in the rotation of a nebulous sphere, where it holds good for all stages of expansion or contraction which are not affected by external influence. Gravitating acceleration should do its whole work in stellar rotation, as well as in planetary revolution. Particles exposed to solar superficial gravitating acceleration, during a single oscillation of half-rotation, would acquire a constant velocity ($gt = v_\gamma$) which is equivalent to the velocity of light. In other words, the unit of velocity which is indicated by the combined constant of solar gravitation and rotation is the same as is indicated by light and by electricity.

280. *Harmonious Development.*

The velocity of light, like the velocity of sound, represents an elastic atmosphere whose height, if homogeneous, would be twice the virtual fall which would give the velocity in question. The analogy is enhanced by the fact that the hypothetical elasticity of the luminiferous æther is in harmonic accordance with solar rotation and planetary revolution. The identity of velocity

$$v_\lambda = v_\varepsilon = v_\gamma$$

represents three simple relations of light, electricity and gravitation. Interpret this fact as we may, it is strongly suggestive of some interplay between sun and matter outside of it, which has determined solar constants. The invariability of v_γ by nebular contraction indicates the same determination for the present and for all future time. If Sun's mass and magnitude are determined by cosmic causes, so that the solar system can always be considered as undergoing a process of harmonious development, the mass, rotation and other solar elements seem likely to be connected by numerical relations, either with other bodies of the system or with cosmical or physical data.

281. *A Fundamental Time-Integral.*

Thomson and Tait (*Nat. Phil.*, i, § 52) speak of the principle of harmonic motion as one of "immense use, not only in ordinary kinetics, but

in the theories of sound, light, heat, etc." Nearly all the results of my physical investigations go to confirm the truth of this statement. The velocity which is involved in the time-integral of projection against a constant gravitating retardation, is measured by gt. The theory of the ballistic pendulum assumes (*op. cit.*, § 298) "that the ball and pendulum are moving on as one mass *before the pendulum has been sensibly deflected from the vertical*. This is the essential peculiarity of the apparatus. A sufficiently great force might move it far from the vertical in a small fraction of its time of vibration. But in order that the time-integral may have its simplest application to such a case, the direction of the force would have continually to change so as to be always the same as that of the motion of the block."

This is precisely the case in the identity of the foregoing note, according to LeSage's hypothesis. The doctrine of correlation of force leads us to look for the simplest forms of harmonic motion at the centres of stellar systems. The simplest value of t, in a harmony of luminous undulation and stellar rotation, is that of a single oscillation of half-rotation. We have no means of knowing whether the identity, $v\lambda = v_\varepsilon = v_\gamma$, holds for any system except our own, but its verification by our sun and the variety of ways in which photodynamic harmonies are deduced are very significant.

282. *A Secondary Time-Integral.*

The harmony between Sun's constrained rotation and luminous undulation warrants an expectation of subordinate harmonies between solar and planetary motions. We may naturally look for the simplest relation in some harmonic motions of Sun and Jupiter. Jupiter is at the nebular centre of the system, on a diameter which is bounded by mean loci of Neptune and Uranus, and the velocity which is involved in its time-integral of rotary oscillation, (gt), is nearly, and perhaps exactly, the same as the limit of planetary velocity in a circular orbit ($\sqrt{gr}$ at Sun's surface). Although planetary revolution at Sun's surface is impossible, the influences which tend to produce it are continuous, and any wave motion which may be thus produced is propagated with uniform velocity through the medium in which the waves originate. The uncertainties in regard to the exact values of Earth's semiaxis major and the apparent semidiameter of Sun and Jupiter, introduce a range of uncertainty into the velocity of Jupiter's time integral, which amounts to about five per cent. Values may be taken which are very near the mean values and which make the accordance exact. This accordance may, perhaps, lead to a special extension and modification of George H. Darwin's beautiful investigations.

283. *A Third Time-Integral.*

The centre which seems to hold the third rank in point of cosmical importance, in the solar system, is the centre of the belt of greatest condensation, which is represented by Earth's orbit. The velocity which is in-

volved in its time-integral of rotary oscillation is slightly less than Jupiter's corresponding velocity, being almost, or quite identical with planetary velocity at the mean centre of gravity of Sun and Jupiter. These successive accordances furnish data for a second "photodynamic problem of three bodies," which is, perhaps, even more remarkable than the one given in Note 254. The importance of the combined harmonies may be shown by a simple recapitulation of the several harmonic velocities, viz. : 1. The identity of Note 280 ; 2. The velocities which correspond with the respective time-integrals of rotary oscillation for the chief centre of nucleation (Sun), the centre of nebulosity (Jupiter), and the chief centre of condensation (Earth) ; 3. The limiting velocity of circular orbital revolution in the system ; 4. The velocity of circular orbital revolution at the centre of gravity of Sun and Jupiter.

284. *Instantaneous Action.*

The case of gravitating action and re-action between Moon and Earth (*Thomson and Tait*, § 276), is the one which led Laplace to his highest estimate of the velocity of gravitating transmission and to suppose that the transmission might be absolutely instantaneous. It is also the case which led Adams (*Ib.* § 830) to the discovery of Laplace's error respecting the theoretical invariability of the mean sidereal day and to the subsequent discussions of tidal friction and retardation. That there is such a thing as instantaneous action is so generally believed that it seems desirable that attempts should be made to furnish some physical representation of its possibility and to demonstrate its influence upon adjustments of equilibrium in cosmical actions and reactions. If frictional accelerations in one portion of a rotating globe can be compensated by frictional retardations in another, or if elasticity (Note 217) aids tidal tendency and wave propagation in making the instantaneous changes which are required by tidal action, our tidal theories need careful revision. The *facts* of harmonic relation which are found on all sides, indicate activities which have been at work in all time, and they should not be ignored for any merely theoretical considerations.

285. "*Harmonic Analysis of Tidal Observations.*"

At the last meeting of the British Association, a special grant of £50 was made to Mr. George H. Darwin, for a Harmonic Analysis of Tidal Observations. Mr. Darwin's success in developing Sir William Thomson's views upon cosmical viscosity, and the beauty of many of his results, give assurance of valuable additions to human knowledge from any work that he may undertake. The accuracy of the conclusions which he has already drawn from Delaunay's hypothesis, is unquestionable. My criticisms (Notes 215–225) upon Prof. Ball's use of those conclusions, were based upon the fact that they did not adequately represent all the elements of the questions which were involved, the laws of intermolecular elasticity and harmonic motion having been almost entirely overlooked. In the absence of any positive evidence of tidal retardation, we have no right to

jump at the conclusion that it is established by the second law of thermo-dynamics. The "reproach" which that law involves is increasingly felt by able investigators (Note 278, 8), and even if it should at last be unanimously admitted that the reproach is unavoidable, it is more satisfactory to suppose a continual restoration of energy by divine supervision, than to believe in the spasmodic alternations of rest and activity, which are taught in the Hindoo mythology.

286. *Refraction of Energy.*

The important cosmical time-integrals and the triple identity of fundamental velocities (Notes, 280–3), seem to be indicative of a continual equivalence of centripetal and centrifugal activities, such as LeSage made the basis of his hypothesis; the rotation of stellar centres serving both to maintain the active energies of the universe and to provide cyclical adjustments of equilibrium. The apparent requirements of thermo-dynamics may, perhaps, be partially satisfied by the probability that the æthereal atmosphere of every star has a relatively hot and a relatively cold hemisphere. It seems possible that all radiations, luminous, thermal, electrical, or kinetic in any other form, may be so refracted, in their passage through the various stellar atmospheres, as to be either reflected from star to star, or transiently absorbed by media which can speedily be enabled, by stellar rotation, to give them out again.

287. *Another Phyllotactic Atomic Divisor.*

The di- and tetratomic group of chemical elements can be more nearly represented by the phyllotactic divisor $\frac{2}{3}$ C = 7.9824, than by 8 H (Notes, 271–2).

		T.	O.	T⌐O.	(Log. T⌐O.)
O	2 D	15.9648	15.9633	.0015	$\bar{3}$.17609
S	4 D	31.9296	31.984	.0544	$\bar{2}$.73560
Se	10 D	79.8240	78,797	1.027	0.01157
Te	16 D	127.7184	127.960	.2416	$\bar{1}$.38310
Mg	3 D	23.9472	23.959	.0118	$\bar{2}$.07188
Ca	5 D	39.9120	39.990	.078	$\bar{2}$.89209
Sr	11 D	87.8064	87.374	.4324	$\bar{1}$.63589
Ba	17 D	135.7008	136.763	1.0622	0.02620
C	2 D	15.9648	11.9736	3.9912	0.60110
Si	4 D	31.9296	28.195	3.7346	0.57224
Ti	6 D	47.8944	49.846	1.9516	0.29039
Zr	11 D	87.8064	89.367	1.5606	0.19329
Sn	15 D	119.7360	117.698	2.038	0.30920
Hg	25 D	199.5600	199.712	.152	$\bar{1}$.18184
Mo	12 D	95.7888	95.527	.2618	$\bar{1}$.41797
W	23 D	183.5952	183.610	.0148	$\bar{2}$.17026
U	30 D	239.4720	238.482	.99	$\bar{1}$.99564
					$\bar{1}$ 0.66435
			17 (log. D = .90213)		15.33621
					17) $\bar{2}$ 5.32814
Logarithm of mean residual,					$\bar{2}$.54871

288. *Another Basis for Estimates of Probability.*

The substitution of $\frac{2}{3}$ C for $\frac{1}{2}$ O or 8 H, in Notes 271–2, not only introduces another evidence of phyllotactic influence upon atomicity, but it also shows that the organic elements, C, H, O, N, stand in important phyllotactic relations to four fundamental groups of elements. If we omit C from the comparison, the remaining elements of the di- and tetratomic group give $\overline{2}.47682$ for their logarithm of mean residual. The respective residuals themselves are $.03538D$ and $.02998D$. I have already considered various probabilities, which were based on Schuster's estimates, as well as relative probabilities which are independent of any absolute estimates. Another satisfactory basis of comparison may be found in the mean limiting value of the residual, $a\neg nD = \frac{D}{5.43654}\ (2\pi D)^{\frac{1}{2D}}$, when the possible residuals are taken in arithmetical progression. If all possible values are thus taken, in other words, if the number of terms is infinite, the second factor becomes unity and the limiting value is $\frac{D}{5.43654} = .18394D$. This is 5.2 times as great as the first of the above mean residuals, or 6.135 times as great as the second.

289. *Resumé of Phyllotactic Atomicity.*

The most satisfactory phyllotactic divisors for the four elementary groups, as indicated by the foregoing notes, are the following: α, for the monatomic group, $H = 1 \doteq \frac{1}{2}.\frac{1}{8}\ O$; β, for the tri- and pentavalent group, $\frac{1}{3}.\frac{1}{8}\ \mathrm{N} = 1.558$; γ, for the di- and tetratomic group, $\frac{2}{3}\ C \doteq \frac{1}{2}\ \mathrm{O} \doteq 8\ H = 7.9824$; δ, for the residuary metallic group, $\frac{1}{2}.\frac{1}{8}\ O \doteq \frac{1}{8}\gamma = .998$. The comparative residual percentages, as deduced from Note 272, and from these divisors are given in the table below:

	S_2.	S_1.	H.	Gerber.	Chase.
Monat.	.20117	.20868	.08483	.11623	.08483
3 and 5	.18626	.15532	.09306	.06510	.06499
2 and 4	.24947	.16498	.12405	.04988	.02998
Metal.	.22497	.20023	.14752	.22172	.06882
Periss.	.19432	.18271	.08344	.08955	.07525
Artiad.	.23414	.18584	.13797	.12460	.04965
Mean	.22089	.18483	.12007	.11237	.05654

290. *Comparative Probabilities.*

The following tables give the comparative probabilities for the several divisors: 1st, if the hydrogen unit; 2d, if $.18394D$ is taken as the unit of probability.

	S_2	S_1	H.	Gerber.	Chase.
Monat.	.4217	.4065	1.0000	.7298	1.0000
3 and 5	.4996	.5991	1.0000	1.4295	1.4318
2 and 4	.4972	.7519	1.0000	2.4868	4.1377
Metal.	.6558	.7368	1.0000	.6653	2.1625
Perissad.	.4551	.4840	1.0000	.9876	1.1753
Artiad.	.5893	.7424	1.0000	1.1073	2.7787
Mean	.5436	.6496	1.0000	1.0684	2.1235

Aggregate, S_2 .000000000000000114; S_1 .00000000000102; H 1; G 69.019; C 853,782,000,000,000,000,000.

Monat.	.9143	.8814	2.1685	1.5825	2.1685
3 and 5	.9876	1.1843	1.9766	2.8255	2.8302
2 and 4	.7373	1.1149	1.4829	3.6876	6.1356
Metal.	.8176	.9187	1.2469	.8296	2.6964
Perissad.	.9466	1.0067	2.0799	2.0541	2.4445
Artiad.	.7856	.9898	1.3332	1.4763	3.7046
Mean.	.8327	.9952	1.5320	1.6369	3.2533

Aggregate, S_2 .00000815; S_1 .735; H 718,725,600,000; G 49,821,227,000,000; C 614,812,000,000,000,000,000,000,000,000,000.

291. *Another Comparative Basis.*

In the above comparisons it seemed best to exclude the elements that were *exactly* phyllotactic multiples of the assumed divisors (H in the 3d and 5th columns; N and C in the 5th). If those elements were considered as uncertain to the amount of .001 H, the results would be modified, by introducing all the elements, as follows: residuals; H_n monatomic, .05859, perissad, .07144, mean, .11154; Chase, monatomic, .05859, tri- and pentatomic, .03891, di- and tetratomic, .03538, perissad, .04916, artiad, .05293, mean, .05168. The comparative mean probabilities would be as follows: S_2 .5050, S_1 .6035, H 1.0000, Gerber .9926, Chase 2.1581. The mean probability of the hydrogen unit, as deduced from the mean accidental residual, would be, 1.9286; of the phyllotactic divisors, 3.5589. That the test of the mean accidental residual is sufficiently severe is evident from the probabilities which it indicates for the surd divisors, S_1 and S_2.

292. *Objection Answered.*

The uncertainity, even of Clarke's recomputation of atomic weights, has been urged as an objection to the acceptance of any apparent probabilities which may be inferred from their examination. If our conclusions were absolute, the objection would be valid, and it must be admitted that even the comparative probabilities will doubtless be greatly modified by the more accurate determination of doubtful atomicities. The modifications, however, would be quite as likely to increase the evidences of phyllotactic influence as to diminish them, if there were no reason to look for such influence. The *a priori* grounds for expecting proof of harmonic action in some shape or

other (Note 281), together with the various physical tendencies to division in extreme and mean ratio (Notes 135, etc.), which make phyllotaxy a simple form of harmony, seem likely to turn the scale largely on the side of its present leaning, so as to make the fact of atomic phyllotaxy more and more evident with each successive increase of precision in atomic measurements. While the mean probability of the hydrogen unit, under the most favorable aspect, is 1.93 times as great as that of any divisor taken at random, the mean probability of the phyllotactic divisors, under the least favorable aspect, is 1.845 times as great as that of hydrogen. If my divisors, like Gerber's, had been purely empirical, there would have been more reason to think that they might lose credit with increased precision of determination, but even then it would be strange if so large a relative advantage were entirely overcome. The successive discoveries that Gerber's divisors are approximately phyllotactic, that their significance is increased by making them exactly phyllotactic, and that the most satisfactory divisors which have yet been found stand in simple phyllotactic relations to the four fundamental organic elements, furnish no ground for expecting any future reversal or weakening of the harmonic indications which I have already set forth.

293. *Photodynamic Precession.*

To the many harmonic evidences of photodynamic action and reaction between the chief centres of nucleation and of condensation, Sun and Earth, may be added one which serves to illustrate and extend the principles that are involved in my first "photodynamic problem of three bodies" (Note 254). If we suppose the photodynamic rotating influence on the æthereal sphere, at the equatorial locus of Sun's modulus of light ($474028 r_0$; Note 263), to be such as would give planetary velocity at the same locus, the time of rotation would be $(474028 \div 214.73)^{\frac{3}{2}} = 103721$ years. If nebular condensation were to begin at that locus and proceed until the primitive velocity of the locus would tend, through viscosity, to become parabolic, the nucleal radius would be reduced to one-half and the time of rotation to one-fourth of the primitive values. The period, or "great year," which is thus indicated (25930.25 years), is virtually identical with a complete revolution of the equinoxes, which Herschel estimates at 25,868 years; Stockwell at $25,694\ 8 \pm 281.2$ years;* Newcomb and Holden "about 25,800 years." This accordance furnishes another reason for believing, with Laplace, in the stability of the physical universe, rather than in the ultimate stagnation which seems to be indicated by the questionable second law of thermodynamics.

294. *Harmonic Rotation of Earth and Moon.*

The improbability of Delaunay's hypothesis is further increased by harmonies of rotation which involve the conjoint action of Sun, Earth and Moon.

* The differences from the mean value being due to secular inequalities.

By taking the rotating locus of the linear centre of oscillation, for Laplace's terrestrial limit, l, we find that the velocity of rotation at $\frac{1}{3}\,l$ is virtually identical with Moon's mean velocity of revolution. Let $l = nr_3$; then $t_a = 2\pi\sqrt{\frac{n^3 r_3}{g_3}} = 86164.1$ seconds; $n = 6.60704$; $\frac{1}{3}\,l = 2.20235 r_3$; velocity of rotation at $\frac{1}{3}\,l = 4.40469\ \pi r_3$ per sidereal day, or $4.41675\ \pi r_3$ per mean solar day. If this is Moon's mean orbital velocity, the circumference of her orbit is $(27.321661 \times 4.41675 = 120.673)\ \pi r_3$. Moon's orbital eccentricity being .0549081, her orbit is $.999246 \times 2\pi a$ and $a = 60.382\ r_3$. Proctor's estimate is $60.263\ r_3$; Littrow's, $60.278\ r_3$; Newcomb's $60.639\ r_3$. See, also, Note 296.

295. *Spectrum of Comet Wells.*

Huggins (*Nature*, June 22, 1882, p. 179) gives a band spectrum, with measured wave-lengths for the brightest portions. Its harmonies are shown in the following comparisons:

	Huggins.	Divisors.	Harmonic.
α	4769	1	4769
β	4634	$1 + a$	4634.2
γ	4507	$1 + 2a$	4507.2
δ	4412	$1 + 2b$	4412.1
ε	4253	$1 + 3b$	4252.9

$$\beta{-}\gamma : \gamma{-}\varepsilon :: 1 : 2$$
$$\gamma{-}\varepsilon : \beta{-}\varepsilon :: 2 : 3$$

In other words, γ is the centre of linear oscillation between ε and β.

Other phyllotactic approximations are indicated by the proportions:

$$\delta{-}\varepsilon : \gamma{-}\varepsilon :: 5 : 8 \text{ nearly.}$$
$$\gamma{-}\varepsilon : \alpha{-}\varepsilon :: 1 : 2 \quad \text{“}$$

These several relations show a primitive phyllotactic tendency, which is controlled and modified by γ and the harmonic divisors. The following values would *exactly* satisfy all the phyllotactic harmonies: 4760.71, 4633.86, 4507, 4411.86, 4253.29.

296. *Harmonic Nebular Time-Integrals.*

The second “photodynamic problem of three bodies,” which is specially implied in my three primitive time integrals (Notes 281–3), may be associated with the first through a harmonic relation which involves Moon's orbital time (t_β), Earth's rotation (t_α), Earth's superficial gravitating acceleration (g_3), and Sun's gravitating acceleration at the perihelion centre of gravity of Sun and Jupiter (g_0). The relation is expressed by the proportion:

$$t_\beta : t_\alpha :: g_0 : g_3$$

The resulting equation, $g_3 t_\beta = g_0 t_\alpha$, indicates two important harmonic time-integrals, which seem much more likely to be permanent, than to be

disturbed and even overthrown by tidal friction and retardation. Since g is taken at the present locus of Jupiter's orbital projection, it seems possible that the lunar disturbance, which Delaunay referred to tidal friction, may have a secular period, which represents some function of Jupiter's secular variations of eccentricity. If we take Leverrier's estimate of Jupiter's present eccentricity, .0482388, and Stockwell's estimate of its secular variation, .0608274, Sun's superficial gravitating acceleration is $1.027\ g_0 = 1.027 \times 27.321661 = 28.059$. This gives $\rho_3 = 92{,}409{,}000$ miles, if we take the oscillatory estimate of Solar mass, and the British Nautical Almanac estimate of Sun's apparent semi-diameter ($m_0 = 331{,}776\ m_3$; $\rho_3 = 214.45\rho_0$). Compare Note 256, *e*.

297. *Two Tidal Questions.*

No physical question can be regarded as satisfactorily settled, until all the known facts which are likely to have any bearing on its solution have been duly considered. Provisional hypotheses may be very properly adopted as occasional and temporary expedients, in order to fix new points of departure, and facilitate the progress of investigation, but even they are defective whenever they are obviously limited and partial. The cosmical importance of harmonic motion, which Laplace demonstrated in his discussions of Jupiter's satellite system, as well as the further evidences of its general physical importance which have been brought forward by Lagrange, Fourier and Thomson, cannot be wisely set aside, even in a provisional hypothesis, through any dogmatic assertion of a thermodynamic requirement, which, if it is not compensated in some way, may possibly lengthen the terrestrial day by a minute interval, which has been variously estimated, from $\frac{1}{800}$ to $\frac{11}{50}$ of a second in a year. Even if the requirement was universally admitted, the relations of photodynamic precession (Note 293), indicate a possible harmonic acceleration which is manifoldly greater than this problematical retardation. Before making any admission which would call for a careful study of this possible acceleration, two questions should be satisfactorily answered: 1. Are the tidal tendencies instantaneously adjusted? 2. Are the local tidal frictions limited to mere terrestrial action, so that the conversion of motion into heat, at one point, is compensated by a conversion of heat into motion at another?

298. *Explosive Waves.*

Berthelot's discovery has already been suggested (Note 278, 6) as one of the important topics for consideration in the study of æthereal correlations. The velocity, $\sqrt{gh}$, which is indicated by the explosive energy of H_2O (Note 16), is $(32.088 \times 68878.2 \times 1389.6 \div 9)^{\frac{1}{2}} = 18473$ ft. $= 3.49865$ miles per second. This velocity is sufficient, under the normal atmospheric pressure at Earth's surface, to produce æthereal waves which are manifested by light, heat and chemical combination. We may accordingly look for like phenomena whenever "subsiding" particles penetrate the

nebulous region of the zodiacal light with a corresponding *vis viva*. Subsidence from Laplace's solar limit (Notes 268, 274), would give a *vis viva* which is more than 10000 times as great, in their passage through the solar atmosphere. These facts should be carefully considered in any investigations which are suggested by the hypothesis of Dr. Siemens. The explosive velocity being acquired long before the subsiding matter reaches Sun's surface, the compounded ascent condensed particles continue sunward into the region of dissociation and centrifugal projection. No sufficient reason has yet been given, for doubting the adequacy of the fundamental time-integral (Notes 280–1) to keep up this circulation indefinitely. Important harmonic analogies are suggested by Neptune's projectile orbital velocity at secular perihelion, and by Jupiter's mean locus of subsidence. According to Stockwell's estimates of the planetary elements, Neptune's secular perihelion velocity is 3.42 miles per second and Jupiter's mean aphelion is 5.4274 ρ_3; the mean proportional between Earth's semi-axis major and Neptune's secular perihelion being 5.4404 ρ_3.

299. *Alternations of Energy.*

All the ordinary assumptions of dissipation of energy take it for granted that the universal æther is able to absorb heat indefinitely, without imparting it again to more condensed matter. If this were the case, why should not the heat be absorbed in its passage from star to star? Judging from atmospheric analogies, we may infer the existence of æthereal convection currents and a greater manifestation of heat with increasing density. If æthereal density varies with pressure, as I have supposed in Notes 35, 236–240, etc., the kinetic theory of gases would imply a constant mean molecular velocity. The tangential character of luminous undulations implies a polarity which would tend to the formation of æthereal spheroids about stellar centres, and if those centres have an orbital motion which is combined with an axial rotation of their respective orbs, the continual changes of relative position would favor a transfer of energy from star to star which, with reflection and refraction (Note 286), might maintain perpetual tendencies to an equilibrium which would never be reached. It seems not unlikely that the thermal relations of every star to its æthereal spheroid may be so adjusted that there is a transfer of heat from the æther to the nucleus during one-half of each rotation, and from the nucleus to the æther during the other half. Such a hypothesis lends a meaning to the fundamental kinetic identity (Note 280), which is in thorough accordance with Laplace's belief in the stability of the solar system.

300. *Actions and Reactions in Moving Radiations.*

Prof. H. T. Eddy (*Sci. Proc.* of the *Ohio Mech. Inst.*, July, *1882*) describes a method for the distribution of heat in a way which conflicts with the second law of thermodynamics. He objects to the so-called axioms of Clausius and Thomson, on the ground of their implicit assumption

that heat is radiated with infinite velocity, inasmuch as they take no account of the states of relative rest or motion of the bodies between which the heat passes. He cites the statement of Kirchhoff, "that the second law cannot be (at present) proved; but it, so far, has never been found in disagreement with experience;" the view of Maxwell and Boltzmann (*Wien Sitzb.*, Bände, lxxvi, lxxviii), that it should be regarded "as merely the mean result flowing from the laws of probability;" Rankine's paper (*Phil., Mag*, [4] iv, 358), in which "he has supposed it possible to reflect radiations in such a way as to give the universe such differences of temperature as to insure it a new lease of life;" and the paper of Clausius (*Mech. Theory of Heat*, chap. xii), showing the general impossibility of such a reconcentration as Rankine supposed, when the radiating bodies are at rest; nevertheless, no such impossibility may finally appear in case of the actual universe which is a system of moving bodies." He closes his discussion with the following sentences: "The point to which I would emphatically direct attention is, that since radiations are known to be moving in space, apart from ponderable bodies, and subject to reflections, it is possible so to deal with them as to completely alter their destination, and successfully interfere with all results flowing from Prevost's law of exchanges. It also seems to me that the exactness of the second law of thermodynamics depends, as far as radiations are concerned, upon that of this law of exchanges." In addition to the reflections to which moving radiations are subject, I have also called attention to their refraction (Note 286), and I have endeavored to co-ordinate all my discussions, through the fundamental identity (Note 280), which implies an equivalent motion of reaction for every radiant action. Moreover, the moving particles in each radiant undulation are all subject to cosmical attractions and perturbations, which have not yet been considered in investigations of the seeming dissipation of energy.

301. *Thrust of Polar Ice-Caps.*

Geologists who believe that the northern hemisphere was once largely covered with ice, have usually attributed the thrust to the simple gravitating pressure of the accumulation at the pole. The position of many of the boulders, and of the supposed terminal moraines, seems to indicate a greater propelling force than many investigators are willing to attribute to the combined action of polar centripetal and equatorial centrifugal energy. Perhaps the unwillingness may be removed by making proper allowance for "the flow of solids," an element of the problem which does not seem to have received any consideration beyond the simple plasticity and regelation which have been studied in connection with the movements of ordinary glaciers. The photodynamic hypothesis of an all-pervading and universally active æther involves the requirement of perpetual tendencies toward equilibrium, and the evidence of such tendencies which is given by Earth's oblateness (Notes 246, 249) furnishes an adequate explanation for many of the glacial phenomena which have hitherto seemed paradoxical. Bessel's estimate of the oblateness is slightly less than would result

from Tresca's "flow;" Clarke's two estimates accord more nearly with the theoretical value; while Listing's, which is the latest of all, gives an agreement which is virtually exact. If we start from his estimate (1 : 288.4), we get $g = \frac{4\pi^2 \times 288.4}{(86164.1)^2} r = 32.086$ ft. Ganot's value is 32.088 ft. It can hardly be believed that such a coincidence is merely accidental. If it is indicative, as I have supposed, of inter-molecular æthereal action, it has an important bearing on tidal equilibrium, and it shows that Earth's shape and rigidity were not fixed in any past age, but are at all times adjusted to the requirements of internal elasticity and external attractions. Any arguments which may be adduced in favor of such an adjustment may be urged, *a fortiori*, in support of the flow and thrust of a plastic material like ice. The velocity of terrestrial rotation, in the mean latitude which Prof. H. C. Lewis has indicated for the terminal moraine in Pennsylvania, is more than 1000 feet per second. The centrifugal force consequent upon such a velocity, together with the thrust of an ice-cap which extended to the pole, must greatly facilitate glacial flow. The equilibrating forces would work upon local glaciers, in the same way as upon a general ice-cap.

The Classification of the Ungulate Mammalia. By E. D. Cope.

(*Read before the American Philosophical Society, May 19, 1882.*)

In the present essay the osseous system is chiefly considered, and of this, the structure of the feet more than of any other part of the skeleton. The ungulata are here understood to be the hoofed placental Mammalia with enamel covered teeth, as distinguished from the unguiculate or clawed, and the mutilate or flipper limbed, and the edentate or enamelless, groups. The exact circumscription and definition is not here attempted, though probably the brain furnishes an additional basis of it in the absence of the crucial, parietoöccipital, calcarine fissures, etc. Suffice it to say that it is on the whole a rather homogeneous body of mammalia, especially distinguished as to its economy by the absence of forms accustomed to an insectivorous and carnivorous diet, and embracing the great majority of the herbivorous types of the world.

The internal relations of this vast division are readily determined by reference to the characters of the teeth and feet, as well as other less important points. I have always insisted that the place of first importance should be given to the feet, and the discovery of various extinct types has justified this view. The predominant significance of this part of the skeleton was first appreciated by Owen, who defined the orders *Perisso-*

dactyla and *Artiodactyla*. Professor Gill* has also used these characters to a large extent, but without giving them the exclusive weight that appears to me to belong to them. Other authors have either passed them by unnoticed, or have correlated them or subordinated them to other characacters in a way which has left the question of true affinity and therefore of phylogeny, in a very unsatisfactory condition. Much light having been thrown on these points by recent discoveries in paleontology, the results, as they appear to me, are here given.

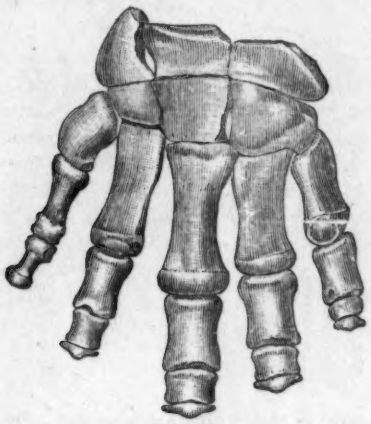


FIG. 1.

FIG. 1.—Left anterior foot of *Elephas africanus* (from De Blainville).

Carpus.—It is well known that in the *Perissodactyla* and *Artiodactyla*, the bones of the two rows of the carpus alternate with each other; that the lunar for instance rests on the unciform, and to a varying degree on the magnum, and that the scaphoides rests on the magnum and to some degree on the trapezoides and trapezium. It is also known that in the *Proboscidea*, another state of affairs exists; *i. e.*, that the bones of the two rows do not alternate, but that the scaphoides, lunar and cuneiform, rest directly on the trapezium and trapezoides, the magnum, and the unciform respectively. The preceding characters are sometimes included in the definitions of the respective orders. Further than this they have not been used in a systematic sense.

Professor Gill says of the carpus of the *Hyracoidea*, "carpal bones in two interlocking rows; cuneiform extending inwards (and articulating with magnum); * * * unciform and lunar separated by the interposition of the cuneiform and magnum." Professor Flower† gives a figure which justifies these statements, but neither the one nor the other agree with my

* Arrangement of the families of Mammals prepared for the Smithsonian Institution. Miscellaneous Collections 230. Nov., 1872.

† Osteology of the Mammalia, p. 266; fig. 92.

specimens. In the manus of a *Hyrax capensis* (from Verreaux, Paris), I find the following condition of the carpus. The bones of the two series are articulated consecutively, and not alternately; they do not interlock, but inasmuch as the magnum is a little narrower than the lunar, the latter is just in contact (anteriorly) with the trapezoides (centrale) on the one side, and the unciform on the other. My specimen agrees with Cuvier's figure of *Hyrax capensis* in all respects. It is probable that Professor

FIG. 2.

FIG. 3.

FIG. 2.—Left anterior foot of *Phenacodus primævus*, one-third natural size (original).

FIG. 3.—Right anterior foot of *Hyrax capensis*; (from Cuvier). *Sc.* scapuloid bone; *l.* lunar; *cu.* cuneïform; *p.* pisiform; *tz.* trapezium; *td.* trapezoides; *m.* magnum; *u.* unciform.

Flower has figured some other species under that name, which besides its peculiarities, is of smaller size than the *H. capensis* (see Fig. 3).

In April, 1875* I described the manus of *Coryphodon* (Bathmodon), showing that the lunar was supported below by the magnum and by parts of the unciform. This carpus has the characters of that of *Hyrax capensis*, with the last named articulation more extensive. This was the first description of the carpus of the *Amblypoda*. In February, 1876,† Professor Marsh described the carpus of *Uintatherium* (*Dinoceras*), and asserted that the bones "form interlocking series." He however states that "the magnum is supported by the lunar and not at all by the scaphoid," a state of things which does not belong to the interlocking carpus. The trapezoides does not join the lunar, but the unciform does so, as in *Coryphodon*. Professor Marsh's figure as to the articu-

* Systematic Catalogue of the vertebrata of the Eocene of New Mexico, p. 24 (U. S. Geol. Survey W. of 100th Mer.).

† Amer. Journal Sci. Arts. xi, p. 167; pl. vi., fig. 2.

lations of the magnum does not agree with his description, as it makes that bone articulate with the scaphoid. The second description is however correct, and the carpus is identical with that of *Coryphodon*. (Fig. 4.)

In the *American Naturalist*, June, 1882,* I have shown that the carpus of the *Condylarthra* is essentially like that of the *Hyracoidea*. (Fig. 2.)

FIG. 4.

FIG. 5.

FIG. 4.—Manus of *Coryphodon* (original). The cuneiform is imperfect.

FIG. 5.—Left posterior foot of *Elephas indicus*; (from Cuvier). *ca.* calcaneum; *a.* astragalus; *n.* navicular; *cu.* cuboid; *ec.* ectocuneiform; *me.* mesocuneiform.

Tarsus.—In the tarsus of the *Perissodactyla* and *Artiodactyla* it is well understood that the cuboid extends inwards so as to articulate with the astragalus, giving the latter a double distal facet. It is also well known that the astragalus of the *Proboscidea* has but a single distal articulation, that with the navicular. It is, however, true that the cuboid is extended inwards, but that it articulates with the distal extremity of the navicular instead of that of the astragalus. It was shown by Cuvier that the astragalus of the *Hyracoidea* articulates with the navicular only, and that the cuboid is not extended inwards so as to overlap the latter. In 1873 Marsh† stated that the astragalus of the *Amblypoda* articulates with both cuboid and navicular. Finally I discovered in 1881,‡ that the astragalus of the *Condylarthra* articulates with the navicular only and that the cuboid articulates with

* Page 522.

† American Journal Science and Art, January, 1873.

‡ American Naturalist, 1881, p. 1017.

the calcaneum only. In the tarsus then there are four types of articula-

FIG. 6.

FIG. 7.

FIG. 6.—Left posterior foot of *Phenacodus primævus*, one-third natural size (original).

FIG. 7.—Right posterior foot of *Hyrax capensis* (from Cuvier). *Ca.* calcaneum; *a.* astragalus; *n.* navicular; *cu.* cuboid; *ecc.* ectocuneiform; *mc.* mesocuneiform; *enc.* entocuneiform.

FIG. 8.

FIG. 8.—Posterior foot of *Coryphodon* (original).

tion, which are typified in the *Condylarthra*, the *Proboscidea*, the *Amblypoda* and the *Artiodactyla* respectively. (Figs. 5-9.)

FIG. 9.

FIG. 10.

FIG. 9.—Hind foot of *Poëbrotherium labiatum* (original).
FIG. 10.—Fore leg and foot of *Hyracotherium venticolum* (original).

Orders.—From the preceding considerations we derive the following definitions of the primary divisions of the Ungulata, which should be called orders. In the first place I find the diversity in the structure of the carpus to be greater in the relations of the magnum and scaphoides, than in the relations between the unciform and the lunar. In other words the trapezoides and magnum are more variable in their proportions than is the unciform. This is directly due to the fact that the reduction of the inner two digits is more usual than the reduction of the external two. I therefore view the relations of these bones as more characteristic. In the tarsus the really variable bone is the cubold. It is by its extension inwards

that the additional facet of the astragalus is produced. Its relations will therefore be considered rather than those of the astragalus in framing the following definitions :

Order I. Scaphoides supported by trapezoides and not by magnum, which supports lunar. Cuboid articulating proximally with calcaneum only..... *Taxeopoda.*

Order II. Scaphoides supported by trapezoides, and not by magnum, which supports lunar. Cuboid extended inwards and articulating with the distal face of the navicular..... *Proboscidea.*

Order III. Scaphoides supported by trapezoides and not by magnum, which with unciform, supports the lunar. Cuboid extended inwards and articulating with astragalus..... *Amblypoda.*

Order IV. Scaphoides supported by magnum, which with the unciform also supports the lunar. Cuboid extended inwards so as to articulate with the astragalus..... *Diplarthra.*

The sub-orders are defined as follows :

I. TAXEOPODA.

There are two, perhaps three sub-orders of the *Taxeopoda;* the *Hyracoidea,* the *Condylarthra,* and perhaps the *Toxodontia.** The *Toxodontia* are however not sufficiently known for final reference.† The sub-orders are defined as follows :

A postglenoid process ; no fibular facet of calcaneum, but an interlocking articulation between fibula and astragalus ; ungual phalanges truncate..... *Hyracoidea.*

A postglenoid process ; no fibular facets on either calcaneum or astragalus ; a third trochanter of the femur ; ungual phalanges acuminate..... *Condylarthra.*

There are a good many other subordinate characters which distinguish the *Condylarthra,* which will be given in my forthcoming volume iv of the Hayden Survey, on the Tertiary Vertebrata of Western America.

II. PROBOSCIDEA.

There may be two sub-orders of this order, the *Proboscidea* and the *Toxodontia.* I do not know the Carpus of *Toxodon,* but if it does not differ more from that of the elephants than the tarsus does ; it is not entitled to subordinal distinction from the Proboscidea. The sub-order of *Proboscidea* is defined as follows :

A fibular articulation of the calcaneum ; no postglenoid process ; no third trochanter of femur..... *Proboscidea.*

* See my remarks on Toxodon, Proceedings Amer. Philosoph. Society, 1881, p. 402.

† The considerable resemblance between the dentition of *Toxodon* and *Hyrax* must not be overlooked.

III. AMBLYPODA.

The sub-orders of this order, as I pointed out in 1873, are two, defined as follows:

Superior incisor teeth; no ali-sphenoid canal; a third trochanter of femur; *Pantodonta.*

No superior incisors, nor ali-sphenoid canal, nor third trochanter of femur; *Dinocerata.*

The difference between the *Proboscidea* and the *Amblypoda* consists chiefly in that the navicular of the latter is shortened externally so as to permit the cuboid to articulate with the astragalus. The cuboid has the same form in both. The peculiar character of the navicular gives the astragalus a different form.

IV. DIPLARTHRA.

This order is called by some authors the Ungulata, but that name is also used in the larger sense in which it is here employed. This appears to be its legitimate application, as the name should, if possible, be used for hoofed Mammalia in general, as its meaning implies. The two well known sub-orders are the following:

Astragalus truncate distally; number of toes odd, the median one the largest.....*Perissodactyla.*

Astragalus with a distal ginglymus; number of toes even, the median two largest.....*Artiodactyla.*

Phylogeny.—The serial arrangement of the bones of the carpus and tarsus seen in the *Taxeopoda*, is probably the primitive one, and we may expect numerous accessions to that order on further exploration of the early Eocene epochs. The modification seen in the more modern orders of *Perissodactyla* and *Artiodactyla*, may be regarded as a rotation to the inner side, of the bones of the second carpal row, on those of the first. This rotation is probably nearly coincident with the loss of the pollex, as it throws the weight one digit outwards, that is on the third and fourth digits, rendering the first functionally useless to a foot constructed solely for sustaining a weight in motion. The alternation of the two rows of carpals clearly gives greater strength to the foot than their serial arrangement, and this may probably account for the survival of the type possessing it, and the extinction of nearly all the species of the type which does not possess it. Here is applied again the principle first observed by Kowalevsky in the proximal metapodial articulations. This author shows that the types in which the metapodials articulate with two carpal or tarsal bones, have survived, while those in which the articulation is made with a single carpal or tarsal have become extinct. The double articulation is, of course, mechanically the more secure against dislocation or fracture.

As regards the inner part of the manus I know of no genus which presents a type of carpus intermediate between that of the *Taxeopoda* and

Amblypoda on the one hand, and the *Perissodactyla* and *Artiodactyla* on the other. Such will however probably be discovered. But the earliest *Perissodactyla*, as for instance *Hyracotherium*, *Hyrachyus* and *Triplopus*, possess the carpus of the later forms, *Rhinocerus* and *Tapirus*. The order *Amblypoda* occupies an interesting position between the two groups, for while it has the carpus of the primitive type, it has the tarsus of the later orders. The bones of the tarsus alternate, thus showing a decided advance on the *Taxeopoda*. This order is then less primitive than the latter, although in the form of its astragalus it no doubt retains some primitive peculiarities which none of the known *Taxeopoda* possess. I refer to the absence of trochlea, a character which will yet be discovered in the *Taxeopoda*, I have no doubt.

The *Taxeopoda* approach remarkably near the *Bunotheria*, and the unguiculate and ungulate orders are brought into the closest approximation in these representatives. In fact I know of nothing to distinguish the *Condylarthra* from the *Mesodonta*, but the ungulate and unguiculate characters of the two divisions. In the *Creodonta* this distinction is reduced to very small proportions, since the claws of *Mesonyx* are almost hoofs. Some of the genera of the *Periptychidæ* present resemblances to the *Creodonta* in their dentition also.

The facts already adduced throw much light on the genealogy of the Ungulate Mammalia. The entire series has not yet been discovered, but we can with great probability supply the missing links. In 1874 I pointed* out the existence of a yet undiscovered type of Ungulata, which was ancestral to the *Amblypoda*, *Proboscidea*, *Perissodactyla* and *Artiodactyla*, indicating it by a star only in a genealogical table. This form was discovered in 1881, seven years later, in the *Condylarthra*. It was not until later† that I assumed that the *Diplarthra* are descendants of the *Amblypoda*, although not of either of the known orders, but of a theoretical division with bunodont teeth.‡ That such a group has existed is rendered extremely probable in view of the existence of the bunodont *Proboscidea* and *Condylarthra*. That the *Taxeopoda* was the ancestor of this hypothetical group as well as of the *Proboscidea*, is extremely probable. But here again neither of the sub-orders of this group represent exactly the ancestors of the known *Amblypoda*, which have an especially primitive form of the astragalus not found in the former. In the absence of an ankle-joint, the *Amblypoda* are more primitive than any other division of the Ungulata, and their ancestors are not likely to have been more specialized than they. It is probable that a third sub-order of *Taxeopoda* has existed which had no trochlea of the astragalus, which I call provisionally by the name of *Platyarthra*.

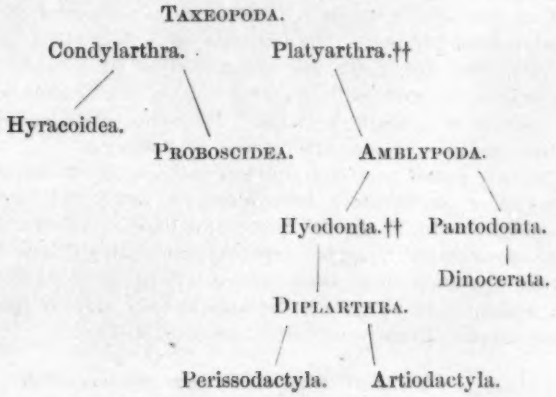
* Homologies and Origin of Teeth, etc., Journal Academy Nat. Science, Philada., 1874, p. 20.

† Report U. S. Geol. Survey W. of 100th Mer., p. 282, 1877.

‡ This hypothetical sub-order is called in the appended scheme, *Amblypoda Hyodonta*.

The preceding paragraphs were written in May of the present year. On my return home, September 1st, after an absence of three months, I find that various parts of the skeleton of *Periptychus** have reached my museum. On examination, I find that the astragalus of that genus fulfils the anticipation above expressed. *It is without trochlea*, and nearly resembles that of *Elephas*. As it agrees nearly with that of *Phenacodus* in other respects I only separate it as a family from the *Phenacodontidæ*. One other type remains to be discovered which shall connect the *Periptychidæ* and the hypothetical *Hyodonta*, and that is a Taxeopod without a head to the astragalus,—unless, indeed, the "*Hyodonta*" should prove to have such a head. I think the latter the less probable hypothesis, and hence retain the term *Platyarthra* for the hypothetical Taxeopod without trochlea or head of the astragalus.

These relations may be rendered clearer by the following diagram:



Third contribution to the History of the Vertebrata of the Permian formation of Texas. By E. D. Cope.

(*Read before the American Philosophical Society, September 15, 1882.*)

Since the publication of my second contribution to this subject,‡ I have described four additional species. These are, in Bulletin of the U. S. Geological Survey of the Territories;§ *Pantylus cordatus* and *Dimetrodon semiradicatus;* in the American Naturalist,‖ *Eryops reticulatus* and *Za-*

* See American Naturalist, October, 1882.

†† Hypothetical.

‡ Paleontological Bulletin, No. 32, Proceedings American Philosophical Society, 1880; the plates, 1881.

§ Vol. vi, 1881, p. 79.

‖ 1881, p. 1020.

trachys apicalis. The last two were not included in my catalogue of the Permian Vertebrata published previously* in the same year. The present paper adds some important points to this remarkable fauna, and explains the hitherto obscure relations of several genera.

DIADECTIDÆ.

The pelvis and sacrum of a species of this group are preserved in my collection, and they indicate further peculiarities of this group.

The sacrum consists of two vertebræ only, and is thoroughly united with the pelvis by its transverse processes. The latter are decurved on the inner side of the iliac bones, and the sutures which distinguish them from the latter and from each other, are not serrate. The inferior arch is robust, but very narrow anteroposteriorly. The acetabulum is entire in every respect, so that it is probable that both pubis and ischium are united undistinguishably in the arch. The pubis is perforated by the usual internal femoral foramen. The posterior edge is grooved, and it might be suspected that this marks the articulation of an ischium. The anterior edge is however grooved in the same way, so that the appearance is rather the position of muscular insertion. The spines of the sacral vertebræ are distinct, and have the usual form seen in *Diadectes*.

The two sacral vertebræ and the absence of obturator foramen, are characters of the suborder *Pelycosauria* in which the latter differs from the *Dicynodontia*. I am still inclined to question whether the extraordinary characters of the cranio-vertebral articulation I have described, justify the separation of the *Diadectidæ* as a third sub-order of the *Theromorpha*, which I have called the *Cotylosauria*,† or whether they are not due to the loss of a loosely articulated basioccipital bone.

EDAPHOSAURUS Cope, genus novum.

Apparently allied to *Puntylus*. Temporal fossæ not overroofed; surfaces of cranial bones not sculptured. Mandibular and maxillary teeth subequal. Posterior half of the mandibular ramus expanded inwards and supporting numerous closely arranged teeth. Pterygoid, or perhaps an internal expansion of the malar bones, supporting a dense body of teeth, corresponding to those of the lower jaw. Teeth subconical.

The single species of this genus in my possession shows the following characters of systematic importance. An arch extends from the parietal plane posteriorly and downwards to the external base of the quadrate. The specimen is not yet in a condition to show how much of this is parietal, and how much squamosal or opisthotic. The proximal half of the posterior part of this arch is a distinct element, perhaps a transverse process of the supraöccipital. A distinct element connects the basioccipital on each side with the quadrate. The articular extremity of the latter has

* American Naturalist Feb., 1881.
† American Naturalist, 1880, p. 304.

a deep anteroposterior concave emargination. There is a flat bone extending from it anteriorly which is apparently pterygoid rather than quadratojugal. The tooth bearing portion terminates opposite the middle of the basisphenoid.

The occipital condyle is undivided, and the basisphenoid presents the usual two divaricating protuberances to the basioccipital.

EDAPHOSAURUS POGONIAS, sp. nov.

Represented by the followsng portions of a skull; basis cranii with portion posterior to the middle of the parietal bone; left maxillary with dental plate, left mandibular ramus entire; various flat bones undetermined. There is also a body which may be the atlas with its arch somewhat dislocated. These pieces are in part covered with a thin layer of the red deposit of the Permian bed in which they occur.

The facial plate of the *os maxillare* is subvertical, so that the orbit is lateral. The latter is rather small. The malar bone is narrow, and is continuous with the dentigerous bone of the palate. The latter has a thickened posterior edge, which commences below the anterior part of the orbit, and extends posteriorly to the middle of the basisphenoid. Thence the border turns forwards. Its anterior edge is below the anterior border of the orbit, and the general form is a longitudinal oval. The maxillary teeth are somewhat weathered and obscured by a thin layer of matrix. The posterior ones are compressed-conic; the premaxillaries are four in number on one side, and are more nearly conic, and have incurved apices. The median premaxillary suture is, however, not clearly defined, so that the number of premaxillaries remains uncertain. The centre of the probable nostril measures one-third the distance from the premaxillary border to the anterior edge of the orbit. There are eight rows of (?) pterygoid teeth at the posterior fourth of the series. The teeth are subequal and obtuse, increasing a little anteriorly.

The mandibular ramus is robust, and the external face slopes inwardly and downwards. The external border rises a little above a few of the posterior teeth, but it is injured at the posterior of the coronoid process, so that its existence cannot be ascertained. The border then descends and turns inwards to the articulation, which is condyloid at its internal extremity. The inferior edge of the anterior part of the ramus becomes a median ridge below the condyloid region, and terminates in a short, compressed angular process. The symphysis is not coössified, and is convex downwards and forwards. The inferior part is subhorizontal, and forms the edge of a transverse plate which is separated from the vertical part of the ramus by a deep groove. The inner vertical face of the ramus is strongly convex, as is the corresponding edge of the symphyseal suture. The apices of the teeth are worn, but they were probably conic, the posterior gradually smaller and more obtuse. The interior face of packed teeth begins at the posterior two-fifths of the external series, and expands in-

wards posteriorly. It contains six longitudinal rows opposite the antepenultimate dentary tooth.

All the bony surfaces are smooth.

Measurements.	M.
Length of mandibular ramus (straight)	.162
" symphysis of do. (straight)	.038
" external dental series	.077
Width of ramus at dental pavement	.040
" skull at ends of OO. quadrata	.138
" extremity of O. quadratum	.024
" occipital condyle	.018
Length of superior dental pavement	.065
Width of basisphenoid posteriorly	.029

The supposed axis vertebra is longer than wide, and the centrum is deeply excavated posteriorly. Anteriorly it appears to have lost a piece—the centrum of the atlas, which, while fitting it closely, was not co-ossified with it. There is a flat horizontal convex ala in the place of a diapophysis, and an obtuse median hypapophysial angle. The neural spine is compressed, except posteriorly, where it is transversely expanded, terminating above in a short obtusely accuminate apex. From this apex an obtuse rib passes down the median line, and disappears above the neural arch, where the spine is somewhat narrower. The postzygapophyses are well developed and look downward.

Measurements of axis.	M.
Length of centrum below	.020
Width, including diapophyses	.035
Elevation of spine from postzygapophysis	.038
Width of do., posteriorly	.020

Remarks.—This interesting form is probably allied to *Puntylus*, which I have hitherto regarded as a Batrachian. The two genera may be placed in a special family of the Pelycosauria, to be called the *Edaphosauridæ*. This family will be distinguished from the *Clepsydropidæ* by the presence of more than one series of teeth on parts of the jaws. It is possible that *Helodectes* must be placed in it.

ECTOCYNODON Cope.

Paleontological Bulletin No. 29, p. 508.

A species now before me resembles in generic characters the type of this genus, *E. ordinatus*. That species was described as having the canine tooth near the middle of the maxillary bone, while in the present one it is near the anterior part of it, as in some other genera. In the typical species, as in the species to be described, the cranial bones are sculptured, and the temporal fossæ are overroofed. The sculptured surface as well as the canine teeth distinguish *Ectocynodon* from *Pariotichus* Cope and *Procolophon* Owen, which genera are otherwise related.

ECTOCYNODON AGUTI, sp. nov.

This reptile is much larger than the *Pariotichus brachyops*, and the anterior part of the cranium has a different form. The general shape of the head is much like that of a rodent mammal of the genus *Dasyprocta*. It is rather wide at the temporal regions, flat above, and narrowed and compressed anterior to the orbits. The muzzle is narrowed and obtuse, and the nostrils are terminal, and are lateral and a little anterior in direction. The maxillary alveolar edge is nearly straight, but the premaxillary edge, beginning below the posterior border of the nares, descends forward at an angle of 45°. Viewed from the front, the premaxillary border is a festoon, strongly convex downwards, and below the anterior part of the nostril. The suture separating the premaxillaries is distinct. The orbits are of moderate size, as in an aguti, and invade the superior frontal plane in a slight degree. The frontoparietal fontanelle is rather large.

The mandible is robust, and presents a short angle. It closes up behind the premaxillary lobate edge. Its teeth are concealed in the specimen. The maxillary teeth increase rapidly in size forwards. The premaxillaries commence smaller next the maxillaries, and increase in size to the first, which is a little larger than the anterior maxillary. The crowns are weathered away. The sculpture on the maxillary and malar bones consists of closely placed shallow fossæ. On the posterior part of the frontals there are strong ridges radiating posteriorly, and situated close together.

Measurements.	M.
Length of skull to end of angle of lower jaw	.090
" " frontoparietal fontanelle	.056
" " orbit, above	.026
" ramus mandibuli	.082
Depth of skull at orbit	.033
" ramus "	.019
Width of skull posteriorly	.068
" " between orbits	.017
" " between external nares	.0105
Diameter of first premaxillary tooth	.003
" second maxillary tooth	.003
Six fossæ of the malar bone	.005
Seven grooves of the frontal bone	.005

This species is much larger than the *Ectocynodon ordinatus* Cope, and the canine tooth has a more anterior position.

Discovered by W. F. Cummins.

DIPLOCAULUS Cope.

Paleontological Bulletin No. 26, p. 187, Nov. 21st, 1877. Proceedings American Philos. Society, 1877, p. 187.

This genus was characterized by me at the places cited, as follows: "Vertebral centra elongate, contracted medially, and perforated by the

foramen chordæ dorsalis, coössified with the neural arch, and supporting transverse processes. Two rib articulations, one below the other, generally both at the extremities of processes, but the inferior sometimes sessile. No neural spine nor diapophysis; the zygapophysis normal and well developed."

This diagnosis was derived from the vertebræ of a single species from the Clepsydrops shale of Illinois, the *D. salamandroides*, and since that description was written, no additional specimens have come under my observation. In the Catalogue of the Vertebrata of the Permian I placed the genus as the type of a family, the *Diplocaulidæ*, among the Pelycosauria. I am now, however, through the energy of Mr. W. F. Cummins, in possession of specimens of a number of individuals of a second species of *Diplocaulus*, found by him in the Permian beds of Texas. From them I derive that the genus and family must be referred to the Stegocephalous Batrachia. It is, however, exceptional among these in the fauna of which it is a member, in not belonging either to the Rhachitomi* or to the Embolomera, since the vertebral centra are not segmented, nor are the intercentra present in any form. Under these definitions it must be referred to the suborder which includes *Oëstocephalus*, *Ceraterpeton*, etc., for which I have adopted Dawson's name Microsauria. The division includes genera with simple amphicœlous vertebral centra, and teeth without inflections of the dentine. The following characters must be added to *Diplocaulus*:

Vertebræ with a more or less perfect zygosphen articulation; centra shorter in the anterior than in the median part of the column; axis and atlas solidly united by a long zygosphen, which is not roofed over by the zygantrum. Neural arch continued as a short tube into the foramen magnum. Atlas unsegmented, and, like the axis, without free hypapophysis. Cervical vertebræ not distinguished from dorsals, and with two-headed ribs.

Orbit separated from the maxillary bone by the union of the lachrymal and malar. Either the malar, or more probably the quadratojugal, extends much posterior to the quadrate bone. It is bounded above by the squamosal, which extends anteriorly to the distinct postfrontal, thus covering over the temporal fossa. Posteriorly it extends into a long, free process, like the operculum of *Polyodon* ossified. This horn does not appear to consist of the epiotic as appears to be the case in *Ceraterpteon*. The quadrate bone is extended very obliquely forwards and its extremity is divided into an hourglass-shaped condyle. In other words the condyle consists of two cones with apices continuous. The internal cone is the smaller, and its base is overlapped from before by a flat bone, probably the pterygoid. The cotyli of the mandible correspond. Mandible without angle; symphysis short.

The teeth are of about equal size, and are rather slender and with conical apex. Their surface is not inflected at any point. The superior series is

* American Naturalist, 1882, p. 334.

double, forming two lines between which the mandibular teeth close. This superior series stands near the external edge of the vomer, palatine and pterygoid bones successively. I have not been able to find any larger teeth in the jaws in this genus. Some fragments mingled with those here described, display such teeth, but I think they pertain to a species of another genus. I know nothing of the limbs of this genus.

DIPLOCAULUS MAGNICORNIS, sp. nov.

The species is indicated by fragments of a number of crania, and portions of several vertebral columns. These were collected at two different localities by Mr. W. F. Cummins.

The skull is very peculiar in the great extent of the parts posterior to the orbits as compared with the portion anterior to them. The posterior border not being complete, the proportions cannot be exactly given, but the part anterior to the orbits is two-thirds the length of the part extending from their posterior border to near the base of the lateral horn, and one-fifth the distance from the orbit to the extremity of the horn. The part of the border of the orbit preserved indicates that the latter is of fair size. It is separated from the maxillary border by at least its own diameter. The external nares are peculiarly situated. They are nearer the orbit than the end of the muzzle, and are close to the maxillary border, being separated from the mouth by a narrow strip of bone only. They are round, open nearly laterally, and are removed from the edge of the orbits by the diameter of the latter.

The malar or quadratojugal bone is protuberant at the canthus oris and projects laterally beyond the mandible at its posterior part. It also projects beyond the extremity of the quadrate bone. This border is continued as that of the external base of the horn, but the portion which belongs to this element is soon distinguished from the superior element (squamosal) which composes the horn, by a groove. This groove is decurved, and bounds the apex of the element, which is a decurved, low tuberosity. The horn is produced backwards in a horizontal plane, forming a long flat triangle which contracts gradually with straight sides. The apex is narrowed, obtuse, and a little incurved. Near and at the extremity the horn is flat above and convex below.

The mandibular quadrate cotylus consists of two fossæ, which together form an approximate figure ∞, of which the internal fossa is the smaller, and opens internally. The external one is nearly transverse. The superior border of the ramus posteriorly is straight. The greater part of the superior aspect is occupied by a huge fossa which opens upwards.

It is uncertain whether the horns meet at an entering angle on the middle line posteriorly or not, but the width of the base of the horn indicates that such is the case. The extremity of the muzzle is depressed, and is broadly rounded.

The external surface of the skull is sculptured in the form of fossæ so distributed that the narrow ridges separating them do not form straight

lines, except in a few places on the superior face of the horn. This sculpture is strongly impressed, and is of medium coarseness. It extends on the inferior face of the quadratojugal (?) posterior to the quadrate, and on the inferior side of the horn at the edges. It is most extended below from the interior edge, and for the terminal inch of the horn, is as well marked as on the superior face. Elsewhere the sculpture of the inferior side passes into punctæ before disappearing. A groove marks the superior boundary of the maxillary bone, which divides when it reaches the superior surface. One branch descends behind the nostril, the other passes transversely across the lachrymal bone and shallows out before reaching the middle line of the muzzle. The mandible is even rougher than the superior surfaces, and has a longitudinal groove below the dental line, to near the symphysis, where it runs out on the alveolar edge. The internal and external sides of the mandible posteriorly, are smooth. On the malar and other facial bones there are four fossæ in 9 or 10 mm.

The atlas is peculiarly flattened above, the neural arch being a tube, without neural spine. Its anterior tubular prolongation is not long, and is deeply notched below. The condyloid fossæ are widely spread transversely and nearly flat, except that their surface is carried forwards on the neural tube. They are well separated below. There is a strong hypapophysial keel, which diminishes and runs out anteriorly. There are prezygapophysial facets, but the postzygapophyses exist. Their superior edge is however carried posteriorly to form the sides of the huge embracing zygantrum. These side processes, which I will call zygantropophyses, extend as far posteriorly as above the posterior end of the centrum of the axis, embracing almost the whole of the neural arch. There is another short median superior process, which notches the extremity of the zygosphen. The side of the atlas between the postzygapophysis and the condyloid facet is wrinkled, and the inferior face finely punctate.

In the axis, the hypopophysis is a large ridge with a horizontal truncate edge. The costal heads of the diapophysis are not split to the base of the latter and the superior is the more robust (extremities broken off). Centrum concave posteriorly, and on each side of hypopophysis with reticulate surface. A short zygantropophysis; zygantrum not large. Exposed summit of zygosphen (nearly equal neural arch) without neural spine. In both the axis and other cervical vertebræ, the superior diapophysis is connected with the zygapophyses fore and aft, in accord with the shortness of the centra. In the more posterior vertebræ they become separated on account of the increasing length of the centrum.

The third vertebra is like the axis, except in having a keel-shaped neural spine, and a short obtuse zygosphen continued from its base anteriorly. With increasing length of centrum the diapophysis becomes longer, and the hypopophysial ridge becomes wider, and coëxtensive with the inferior face of the centrum. It is separated by an angle from the sides in the longer vertebræ; in those of intermediate length, the inferior face is

convex. All of them retain the delicate lines and punctæ of the inferior surface. The neural spine on the more elongate vertebræ is a rather elevated keel, with horizontal superior edge. Its posterior extremity forms a wedge-like zygosphen. The zygantrum is a deep V-shaped cavity, opening posteriorly and not roofed over at any point unless for a small part of its fundus. The zygapophyses are well spread, and have horizontal faces. Each of the columns of the diapophysis sends a ridge forwards, which enclose a groove between them.

Measurements of vertebræ.	M.
Length of atlas below	.015
" " at zygantropophyses	.029
Expanse " " condyloid facets	.034
" of centrum atlas behind	.0145
Depth of atlas at middle	.019
Length of axis below	.015
" " at zygantropophyses	.016
Width of zygosphen above	.011
Expanse of postzygapophyses	.024
Width of centrum posteriorly	.012
Depth " "	
Length of centrum of another (No. III)	.018
" " " (No. IV)	.022
Expanse of postzygapophyses of do	.018
Length of centrum of No. V	.022
Diameters centrum V anteriorly { vertical	.013
{ transverse	.012
Expanse prezygapophyses	.021
Elevation of neural spine from centrum	.011
Diameters centrum No. VI { anteroposterior	.023
{ vertical	.011
{ transverse	.013

The vertebræ of this species are very much larger than those of the *D. salamandroides*, and the diapophyses do not originate so low down on the centrum. Otherwise they are much alike. The cranium of the Illinois species is yet undetermined.

The *D. magnicornis* was discovered by W. F. Cummins.

ACHELOMA. Cope, genus novum.

Order Rhachitomi; family Eryopidæ,* differing from *Eryops* in the absence of notch of the posterior border of the skull between the epiotic and quadrate or squamosal bones, and in the absence of condyles of the humerus.

Mandible without angular process. Teeth of the jaws subequal, rather larger anteriorly; some large ones on the *os palatinum* at different points

* American Naturalist, 1882, p. 335.

along the external margin. Pterygoid bone ending in a free decurved edge anterior to the quadrate bone. Palatines and pterygoids narrow, leaving a wide palatal foramen. Vertebræ in their principal features as in *Eryops*. The humerus is unlike any of those enumerated in my synopsis of Permian humeri,* but resembles the one figured by Gaudry as belonging to *Actinodon*, except that in *Achëloma* there are no condyles, and there is an epicondylar foramen. This is the first time I have observed the foramen in a Batrachian, though it is universal, so far as known, in the Pelycosauria. As in *Actinodon*, there is a short process above the external epicondylar angle.

The absence of humeral condyles in this genus is paralleled by the same feature in *Clepsydrops natalis*. It looks as though the animal were young, and had not yet attained to the coössification of epiphyses. This theory may account for the condition of the humeri in the two species mentioned. It occurs equally in the *Trimerorhachis insignis*. As all these species show every other indication of maturity, and as I have never yet observed free epiphyses in any of my numerous Texan collections, I am disposed to look on this condition of the humeri as a case of permanent incompleteness, of which the Batrachia present so many instances.

ACHELOMA CUMMINSI, sp. nov.

This animal is represented by a greater part of a skull and vertebral column, with both humeri and scapulæ and various other bones of the limbs, including phalanges. All of these remains look a good deal like *Eryops megacephalus*, and they might be supposed on hasty examination to belong to the young of that species. On a full investigation the following differences appear, besides those already mentioned in the generic diagnosis.

The muzzle is relatively much shorter, and the extremity is less depressed; the length from the supraöccipital forwards, is a little less than the total width at the same point. In agreement with this, the mandibular rami, after diverging strongly from the symphysis, are strongly incurved to the quadrate, a form not found in *E. megacephalus*. The sculpture is more sharply defined in the present species. In the vertebræ, although the intercentra have the same degree of ossification as in the *E. megacephalus*, the neural spines have not the expanded head of those of the larger species, but look as though they had lost an epiphysis, as in the case of the humeri. They are erect, with subquadrate section, and not oblique and grooved as *Trimerorhachis insignis*. The diapophyses are more elongate than in *E. megacephalus*, and their extremities frequently have a subround or suboval section, and but few have the narrow surface seen in *E. megacephalus*. The ribs are short and flat, and have the distal extremities expanded paddle-shape. Laid backwards such a rib reaches to the posterior edge of the third diapophysis posterior to the one to which it is attached.

* Proceedings American Philos. Soc., 1878, p. 528.

The form of the skull is triangular, with rounded apex or muzzle, and a slight contraction behind the nostrils. The latter are near the edge of the jaw and open equally laterally and superiorly. The orbits are of medium size, and are as far from the edge of the jaw as the width of the interorbital space, which is about as wide as the diameter of an orbit. The posterior "table" is flat with decurved lateral edges, which rest in a squamosal suture on the squamosal or quadratojugal and quadrate bones. Its posterior angle is produced downwards and backwards to near the distal extremity of the quadrate. The latter slopes posteriorly and downwards. The quatratojugal region is strongly convex in vertical section. The mandibular ramus is strongly incurved posteriorly, from a point opposite the free extremity of the pterygoid. The symphysis mandibuli is short.

The sculpture is distinct on all the superior surfaces of the skull, and consists of fossæ of medium size, bounded by irregular narrow ridges. There are three fossæ in 10 mm. The fossæ are obsolete on the extremity of the muzzle and on the anterior part of both jaws.

The teeth are a little longer on the premaxillary than on the maxillary bone. There are five on each, or six, if the tooth below the nostril belongs to the premaxillary bone. The palatine teeth are much larger. The first, perhaps standing on the external edge of the vomer, is a little posterior to the line of the external nostril. The second is half way between the nostril and orbit, and the third is alongside of and just posterior to it. The fourth is opposite a point a little posterior to the middle of the orbit. Their surface is as yet obscured by a thin layer of fine indurated mud, which in some instances cannot be removed without destruction of the tooth surface.

The intercentra of the vertebræ are, as in *Eryops megacephalus*, ossified so as to nearly cut off the chorda dorsalis, but unlike that species they are not notched on one side of their lateral apices. The extremities of the neural spines are subquadrate, rounded behind, and flattened anteriorly. The edges of the postzygapophyses are prominent and flared upwards.

The scapula is robust and flat, having the posterior-external border longest, and concave and the superior-posterior, convex. In my specimens the thin anterior edge is broken. The coracoid appears to be coössified with the proximal external edge of the scapula, and is directed downwards and backwards. Its extension is small, and terminates in an apex posteriorly, and a thick double edge inferiorly. The glenoid cavity borders this edge, and is small. The epicoracoid if it existed, is lost. The thick inferior edge of the coracoid and scapula, is similar to those of the humerus and vertebral processes, which suggest a cartilaginous cap. The position of the scapula and coracoid is peculiar. If the glenoid cavity is directed outwards, the ribs adherent to them fit their extremities, from which they have been broken, which adhere to the vertebræ. This is probably the natural position. When thus placed, the plate of the scapula is horizontal transversely, and inclined upwards and posteriorly at 30°. The coracoid

is vertical. When in place, there is a large tuberosity above and anterior to the glenoid fossa, immediately behind which is a wide shallow fossa.

The curve of the proximal extremity of the humerus is a semicircle. That of the distal end is less convex, being flattened at the middle. Viewed proximally the proximal end is a little concave on one side, and one extremity of the articular surface is expanded and rounded. Viewed distally, the distal extremity is angulate concave, the middle portion being straight and the extremities bent in the same direction, one being longer than the other, and neither expanded. The entire extremity makes an angle of 90° with the plane of the proximal end. The epitrochlear foramen is protected by a strong bridge.

Measurements.

Skull.	M.
Length to line of angles of mandible	.188
" posterior edge of supraöccipital	.168
" line of posterior edge of orbit	.121
" " anterior edge nares	.017
" " extremity of pterygoid	.142
Width of skull at angles of mandible	.134
" " " greatest	.158
" " just behind nares	.051
" " at nares	.054
" of cranial table at middle	.086
" between orbits	.030
Length of a premaxillary tooth	.011
Diameter of base of do	.004
Length of a median maxillary tooth	.007
Diameter of base of do	.004
Length of a median palatine tooth	.021
Diameter of same at base	.009
Depth of ramus mandibuli at angle	.015

Vertebræ and Ribs.

Diameters of intercentrum	transverse	.018
	antroposterior	.010
Total elevation of same vertebra		.027
Elevation of neural spine above postzygapophysis		.005
Total expanse of diapophyses of same		.027
Length of diapophysis from postzygapophysis		.0095
Diameter of end of	neural spine	.206
	diapophysis transverse	.004
	diapophysis vertical	.006
Length of rib of 5th vertebra in advance of the vertebra measured		.038
Width of rib distally		.027

Scapular arch.	M.
Length of scapula on anterior face	.069
Width do. at antero-internal distal angle, transversely.	.032
" of coracoid and epicoracoid at glenoid cavity, from edge of scapula	.023
Length of epicoracoid and coracoid	.037
" humerus	.064
Width of shaft at middle	.016
Diameters proximal end { long	.039
Diameters proximal end { short at middle	.010
Diameters distal end { long	.039
Diameters distal end { short at middle	.010
Length ungual phalange	.004
" second "	.0075
" first "	.0135
Width do. { proximally	.010
Width do. { distally	.008

This species was discovered by Mr. W. F. Cummins, to whom I dedicate it with much pleasure.

ANISODEXIS Cope, genus novum.

Class Batrachia; order Rhachitomi; family Eryopidæ. Teeth on premaxillary, maxillary, and dentary bones of unequal lengths, some very large, others very small. Dentinal inflections straight, nearly reaching the pulp cavity. Cranial surfaces sculptured.

This genus differs from all the others of the *Eryopidæ*, in the great and abrupt inequality of the teeth of the external series of the mouth, resembling in this respect some of the Saurians of this deposit, rather than the batrachia. Whether it possesses long palatine or pterygoid teeth such as most of the latter exhibit, is not rendered clear by the specimens, but appearances indicate the presence of one near the anterior part of the maxillary. Mandibular series simple.

ANISODEXIS IMBRICARIUS Cope, sp. nov.

Founded on numerous fragments of the skull with jaws, and a vertebral arch and spine found in connection with the remains of the *Diplocaulus magnicornis*. These pieces indicate a larger species than the latter, and are nearly equal to the *Eryops megacephalus*. The jaws are not preserved entire, but portions from different parts of the length display the dental characters.

The sculpture of such parts of the superior surface of the skull is a coarse reticulation, coarser than in any other species known to me. Near the edges, some of the bones become smoother, and the ridges flatten into overlapping laminæ. The entire sculpture of the dentary bone is of this imbricate character, the apparent overlapping being from before back-

wards, and below upwards. This is totally different from what is observed in the other known species of *Eryopidæ*, *Trimerorhachidæ*, and *Diplocaulidæ*. The teeth are round in section, but become lenticular near the apex, developing low cutting edges. The basal grooves are fine, but distinct, and extend half way to the apex, or farther. One large, and one medium sized teeth stand on each dentary bone near the symphysis, and there are two similar ones at a point further back on the same bone. Near the anterior part of the maxillary, below the ?nostrils, is a huge tooth, with a graduated series of small teeth posterior to it, and a very small one anterior to it.

The neural arch of a vertebra has a well developed vertical spine. Its neurapophysis rested in an oval fossa of the centrum which probably was divided into pleurocentra. The prezygapophyses are very small, and look directly upwards. The postzygapophyses are much larger, and look obliquely outwards and backwards. The spine is not expanded at the summit, and is granular, as though it was protected by a cartilaginous cap. Its section is anteroposteriorly lenticular, with acute edge (angle) posteriorly, and a very narrow truncate edge anteriorly. The latter is bounded below just above the root of the neural arch by two little fossæ. The posterior keel is bounded below by a corresponding single fossa. The posterior acute edge of the spine is dentate, and the surface on each side of it, is beveled with rabbeted surfaces as though for a coarse squamosal suture. But the appearance of suture is fallacious, and is simply due to contraction of the transverse diameter of the spine. The neurapophysis is much narrower anteroposteriorly than the neural spine.

Measurements.	M.
Depth of maxillary bone at large anterior tooth	.037
" dentary at symphysis	.025
" " near middle	.021
Width " " "	.015
Diameter of base of large maxillary tooth	.010
" " small maxillary tooth	.0035
Length " " " "	.008
" of large mandibular tooth near symphysis	.016
Diameter of base of crown of do	.006
Elevation of neural arch	.037
Diameters neural spine { vertical	.029
Diameters neural spine { at apex { anteroposterior	.019
Diameters neural spine { at apex { transverse	.012
Width neurapophysis anteroposteriorly	.010

From Mr. W. F. Cummins' collections.

I had thought at one time that this species might be referable to the genus *Leptophractus* of the Coal Measures. No trace of the vertebræ of the Rhachitomous order has yet been found in that formation in this country, nor have any of the Coal Measure genera of Batrachia yet been found in

the Permian of the United States.* It is not improbable that such occurrence of genera may yet be substantiated, but the identification of an order hitherto unknown in a formation, on uncertain characters, is not a safe proceeding. The vertebræ of *Leptophractus* although not certainly known, are supposed to be of the Labyrinthodont type. The teeth are much more compressed and trenchant than in the present species, nor do there appear to be any long ones near the symphysis mandibuli. I consider the question of reference to Leptophractus to be still an open one.

The family *Eryopidæ*, though abundant in individuals, is not represented by many species. They are presumably as follows:

Anisodexis imbricarius Cope.
Acheloma cumminsi Cope.
Eryops reticulatus Cope.
Eryops ferricolus Cope (*Parioxys olim*).
Eryops megacephalus Cope.
Actinodon frossardi Gaudry.
Zatrachys serratus Cope.
Zatrachys apicalis Cope.

But the occipital condyles are unknown in *Acheloma* and *Zatrachys*.

I may add here that through the courtesy of Messrs. Scott and Osborne, I have seen, in the Museum of Princeton College, vertebræ of some species of the Rhachitomi from Saarbrücken, along with *Archegosaurus*, with entire centra, from the same locality.

Synopsis of the Vertebrata of the Puerco Eocene epoch. By E. D. Cope.

(*Read before the American Philosophical Society, October 20, 1882.*)

REPTILIA.

CROCODILIA.

Crocodilus sp.
Crocodilus sp.
Crocodilus sp.

TESTUDINATA.

Plastomenus ? communis Cope.
Dermatemys sp.
Compsemys sp.
Emys sp.

* *Peplorhina arctata* Cope, from the Illinois Permian, is not a *Peplorhina*, but a Theromorph Saurian.

CHORISTODERA.

Champsosaurus australis Cope, American Naturalist, 1881, p. 690.
Champsosaurus puercensis Cope, Proceedings American Philosophical Society, 1881, p. 195.
Champsosaurus saponensis Cope, Loc. cit. 1881, p. 196.

MAMMALIA.

MARSUPIALIA.

Ptilodus mediaevus Cope, American Naturalist, 1881, p. 922.
Ptilodus trovessartianus Cope, loc. cit. 1882, p. 686.
Catopsalis foliatus Cope, loc. cit. 1882, p. 416.
Catopsalis pollux Cope, loc. cit. 1882, p. 685.
Polymastodon taõensis Cope, loc. cit. 1882, p. 684.

BUNOTHERIA.

Taeniodonta.

Hemiganus vultuosus Cope, loc. cit. 1882, p. 831.
Tæniolabis scalper Cope, loc. cit. 1882, p. 604.

Tillodonta.

Psittacotherium multifragum Cope, l. c., 1882 p. 156.
Psittacotherium aspasiæ Cope, Proceed. Amer. Philosophical Society, 1882, p. 192, (1882).

Mesodonta.

Pelycodus pelvidens Cope, Proceeds. Amer. Philos. Soc. 1881, (1882) p. 151. *Lipodectes pelvidens* Cope, American Naturalist. 1881, p. 1019.
Hyopsodus acolytus Cope, sp. nov.

This the least species of the genus, is also the oldest, being derived from the Puerco horizon. Parts of two individuals furnish the characters of the inferior and superior true molars, and the fourth superior premolars. The species differs from those hitherto described in other characters than the minute size. One of these is the absence of posterior interior cusp, the heels of the first and second true inferior molars being bounded by a ridge only at this point, as in most of the species of *Pelycodus*. The last inferior molar is not smaller than the second, nor longer. The anterior cusps of all the molars are robust, so that on the first and second true molars they are separated by a shallow notch only. There is a rudiment of the anterior inner cusp on the first true molar but none on the second and third. The posterior external is obtuse and has a triangular section on all the molars; a crest is continued from the heel of the third molar on the inner side of the crown half way to the anterior inner cusp.

The *Microsyops spierianus* differs from this species in its smaller size (true molars .008) and in the presence of posterior internal cusps of the true molars.

The *Hyopsodus acolytus* was found by Mr. D. Baldwin, in New Mexico.

CREODONTA.

Sarcothraustes antiquus Cope, Proceeds. Amer. Philos. Soc. 1881 (1882), p. 193.

Dissacus carnifex Cope, Amer. Natst. Oct. 1882 (Sept.), p. 834.

Dissacus navajovius Cope, loc. cit. 1881, p. 1019. *Mesonyx navajovius* Cope, Proceeds. Amer. Philos. Society, 1881, p. 484.

Triisodon quivirensis Cope Amer. Nat. 1881, p. 667.

Triisodon heilprinianus Cope, Proceeds. Amer. Philos. Soc. 1881 (1882), p. 193.

Deltatherium fundaminis Cope, Amer. Nat. 1881, p. 237; 1881, p. 337. *Lipodectes penetrans*, loc. cit. 1881, p. 1019.

Deltatherium baldwini Cope.

This Creodont is known only from a portion of a right mandibular ramus which supports the two last premolars, and the first true molar with part of the second. It differs from the *D. fundaminis* in its materially smaller size, and in the forms of the teeth. The first true molar is a more robust tooth, and the basis of the posterior or heel crest is more rounded, and less angulate. The anterior inner cusp projects less anteriorly. The fourth premolar has a distinct anterior basal lobe which is wanting in the *D. fundaminis*. Its heel is short and wide, and the posterior face of the principal cusp is flat, and there is a rudiment of an internal tubercle on its side. The second premolar is elevated and acute, has no anterior basal lobe, and has a very short wide heel, enamel slightly roughened. The animal was rather aged.

Measurements.		M.
Length of P-m. ii and iii and M. ii		.0160
Diameters M. i	anteroposterior	.0058
	transverse	.0040
Elevation of crown of P-m. iii		.0052
Depth of mandible at M. i		.0180

From the Puerco beds of N. W. New Mexico. Dedicated to Mr. D. Baldwin, the discoverer of the Mammalian Fauna of the Puerco beds, which is one of the most important in the history of American Palæontology.

Deltatherium interruptum Cope.

The smallest species of *Deltatherium* is, like the *D. baldwini*, only represented by the anterior part of a right mandibular ramus, which supports the last premolar and the first true molar, with the bases of the other pre-

molars and part of the canine. The canine is small and the first premolar in accordance with the generic character, is wanting. The second premolar is two-rooted. The fourth has an elevated principal cusp, and a narrow heel on the inner side of the posterior base; anterior base injured. The first true molar has very little sectorial character, and resembles the corresponding tooth of a *Pelycodus*. It differs entirely from that of the *D. fundaminis* in the possession of a well marked posterior internal cusp, which is connected by a ridge with the large internal lateral cusp of the heel. The anterior cusps of opposite sides sub-equal. A weak external basal cingulum on the anterior half of the crown; no internal cingulum. Enamel of the tooth wrinkled.

Measurements.	M.
Length of premolar series	.0140
Elevation of P-m. iv	.0040
Diameters of M. i antero posterior	.0055
Diameters of M. i transverse	.0042
Depth of ramus at P-m. i	.0090
" " M.	.0113

On comparison with the *D. fundaminis*, the first molar tooth has the same dimensions, but the premolars are considerably smaller. The ramus is also shallower. Found by Mr. Baldwin in the Puerco beds of Northwest New Mexico.

Didymictis haydenianus, sp. nov.

This creodont is represented by parts of the maxillary and mandibular bones of the left side, the former supporting the four, and the latter supporting the three last molars. The arrangement of the superior molars is much as in *D. protenus*, the fourth premolar being a true sectorial. The third premolar has no internal lobe, although the section of the base of the crown is narrowly triangular. It has anterior and posterior basal lobes, and a posterior lobe on the cutting edge. In the sectorial the median lobe is a good deal more produced than the posterior, though the two form together the usual blade. The anterior basal lobe is distinct; and the internal is larger and is conic. The first true molar has the anterior external base of the crown produced. Its two external cusps are conic and distinct. The internal part of the crown is rounded and supports a conic internal tubercle, which is separated from the external cones by two small concentric tubercles. The second true molar is considerably smaller, and is transverse, its external border being very oblique. It has an acute internal lobe.

The character of the species is well-marked in the inferior true molars. The first has the form seen in other species of *Didymictis*. The heel is large, and with a median basin between lateral cutting edges. The two anterior inner cusps are of equal elevation and are near together; the external is much larger. The last molar is elongate, but reduced in size. Its anterior three cusps, rudimental in other species, are here elevated, forming the triangular mass seen in the first true molar. They are not so

elevated, however, as in that tooth, and thus not so much developed as in *Oxyæna*, *Stypolophus*, etc. The fourth premolar has a median cutting edge on the short heel.

Measurements.	M.
Length last four superior molars	.022
" P-m. iii	.0065
" " iv	.0085
Width " "	.0050
Diameters M. i anteroposterior	.0055
Diameters M. i transverse	.0088
Diameters M. i oblique external	.0072
Diameters M. ii anteroposterior	.0027
Diameters M. ii transverse	.0055
Diameters inferior M. I anteroposterior	.007
Diameters inferior M. I transverse	.005
Diameters inferior M. II anteroposterior	.0055
Diameters inferior M. II transverse	.003
Depth of ramus at M. II, (squeezed)	.010

The peculiar characters of the last inferior molar distinguish this species from its congeners. The last superior molar is relatively smaller than in the *D. protenus*. In size this species is superior to the *D. dawkinsianus*, and is smaller than the *D. leptomylus*. It is dedicated to the distinguished geologist, Dr. F. V. Hayden.

New Mexico, D. Baldwin.

TAXEOPODA.

CONDYLARTHRA.

Periptychidæ.

Periptychus rhabdodon Cope. *Catathlæus rhabdodon*, American Naturalist, 1881, 829.

Periptychus carinidens Cope, loc. cit. 1881, p. 337.

Periptychus ditrigonus Cope, sp. nov.

This rare species is known from a right mandibular ramus, which exhibits part of the symphyseal suture, with the alveoli of the molar teeth, except the first. The only well preserved crown is that of the second true molar.

The second true molar presents very peculiar characters, and the mandibular ramus is shallower and thicker than in the two other species of *Periptychus*. The former has a wide external cingulum which is not present in the other species, and there are only six cusps instead of seven. These are peculiarly arranged. The anterior three are much as in *P. rhabdodon*, the anterior being not quite so far internal as the posterior inner, close to it, and as large as the anterior external. The posterior three, are a posterior inner and posterior median as in *P. rhabdodon*, and a peculiarly placed posterior external. This is not

opposite the posterior inner, but is anterior to such a position and intermediate between the latter point, and the one occupied by the median tubercle in *P. rhabdodon*. It is as large as the anterior external tubercle. All these tubercles are conical, and not connected by angles or ridges. The posterior external cusp leaves the cingulum wide posteriorly, and its edge develops some small tubercles. There are also some small tubercles at other points on the edge of the crown, but no other cingula. The enamel is not regularly ridged as in *P. rhabdodon*, but has a rather coarse obsolete wrinkling.

Measurements.		M.
Length from P-m. ii to M ii inclusive		.052
Diameters of M. ii	anteroposterior	.011
	transverse	.010
Depth of ramus at M. ii		.022
Width of " "		.016
Depth of " "	P-m. ii	.019

From the Puerco formation of New Mexico, D. Baldwin, discoverer.

Haploconus lineatus Cope, Amer. Nat. 1882, p. 417.

Haploconus angustus Cope, Loc. cit. 1882, p. 418. *Mioclænus angustus* Cope, loc. cit. 1881, p. 831.

Haploconus xiphodon, sp. nov.

This species is represented by a mandibular ramus, and perhaps by three rami. The one on which the species rests contains five molars, the middle one of the series broken, so that its form cannot be positively ascertained. It is probable that it is the first true molar, so that the animal exhibits the last true molar not entirely protruded, and is therefore nearly adult, but there are some reasons for suspecting it to be young. Thus the last inferior molar does not exhibit more of a heel than the second usually does, and the third supposed premolar is smaller than that tooth is in the other species, having nearly the proportions of the second premolar. The teeth present may then be supposed to be the molars from the second to the sixth inclusive. But opposed to this view is the fact that the supposed third premolar has more the structure of that tooth in details, than that of the second, and the specimens accompanying, which have the temporary dentition apparently of the same species, present premolar teeth of a very different character. In any case the present specimen represents a third species of the genus, and I describe it at present as an adult.

The third premolar has a simple compressed crown, about as high as the length of its base, and without anterior basal tubercle. It has a narrow triangular posterior face which is concave, and truncated by a cingulum below; no heel proper, nor lateral cingula. The fourth premolar is an elongate tooth consisting of a compressed principal median lobe, an anterior lobe connected with it, and a heel. The latter has elevated posterior and interior borders. A rudiment of an exterior border is seen in a narrow

ridge on the external side of the posterior face of the principal lobe of the tooth.

The sides of the premolars present rather distinct ridges, as in *Peripty-chus carinidens*. The second true molar has two anterior and three posterior tubercles; the latter close together, pointed and of about equal size. Of the anterior tubercles, the external is much the larger and more elevated. It is compressed and has a curved subacute anterior edge, which extends much in front of the internal tubercle. There is no anterior inner tubercle, nor are there any cingula. The enamel of the sides of the crown presents a few vertical ridges. The last inferior molar only differs from the second, in the greater size of the median posterior lobe, which is nevertheless smaller than in the two other species of *Haploconus*.

There is a mental foramen below the posterior edge of the second inferior premolar.

Measurements.	M.
Length of last five inferior molars	.0250
" third premolar	.0050
" fourth premolar	.0066
" second true molar	.0050
Width of second true molar	.0032
Length of third true molar	.0050
Depth of ramus at P-m. iii	.0095
" " M. iii	.0130

The two rami with the temporary premolars, exhibit the last true molar enclosed in the jaw. The third and fourth premolars are much like the fourth premolar of the specimen above described, but the fourth is a little more robust than that of the latter, which is very much like the third of the deciduous series. The space occupied by the supposed first premolar of the type specimen is too short for the fourth premolar of the deciduous series, otherwise it might be supposed to have occupied that position. The two true molars resemble those of the type, excepting that the last one does not extend so far into the base of the coronoid process, and is in accordance with the position as number two in the series.

The specimens were procured by Mr. D. Baldwin in the Puerco beds of New Mexico.

Haploconus entoconus Cope, loc. cit. 1882, p. 686.

Anisonchus coniferus Cope, loc. cit. 1882, October (September), p. 832.

Anisonchus gillianus Cope. *Haploconus gillianus* Cope, loc. cit., 1882, p. 686.

Anisonchus sectorius Cope, Proc. Amer. Philos. Soc. 1881, p. 488, *Mioclaenus sectorius*, Amer. Nat. 1881, p. 831.

Hemithlæus kowalevskianus Cope, Amer. Nat. 1882, p. 832.

Hemithlæus opisthacus Cope. *Mioclænus opisthacus*, l c. 1882, p. 833.

Conoryctes comma Cope American Naturalist, 1881, p. 829.

PROC. AMER. PHILOS. SOC. XX. 112. 3G. PRINTED NOVEMBER 18, 1882.

Conoryctes crassicuspis Cope.

The posterior part of a mandibular ramus supporting the last two molar teeth indicates a second and larger species of the genus. The ramus is one-half deeper than that of the *C. comma*, and the second true molar is much larger than in that species. The last true molar is much smaller than the the penultimate, and consists of three anterior cusps and a longer heel. The former are obtuse, the external the longer, the internal equal, the anterior on the inner edge of the crown. The heel sustains a low conic tubercle.

From the Puerco beds of N. W. New Mexico.

Phenacodontidæ.

Protogonia plicifera Cope, Amer. Nat. 1882, Oct. (Sept.), p. 833.
Protogonia subquadrata Cope, Proceedings Amer. Philos. Soc. 1881, p. 492
Phenacodus puercensis Cope, Proc. Amer. Philos. Soc. 1881, p. 492.
Phenacodus cuniensis Cope, loc. cit. p. 492; loc. cit. 1881 (1882), p. 180.
Pantolambda bathmodon Cope, Amer. Nat. 1882, p. 418.
Mioclænus turgidus Cope, Amer. Nat. 1881, p. 830.
Mioclænus minimus, sp. nov.

This is one of the least mammalia of the Puerco fauna, exceeding by a little the *Hyopsodus acolytus*. It is represented by parts of two mandibles, which display all the true molars. As there are no premolars preserved, its reference to the genus *Mioclænus* is provisional only, but its true molars have the peculiar characteristics of those of the *M. turgidus*.

The two anterior cusps of the true molars are higher than the heel, and they are united together to a point above the level of the heel. The section of both those of the M. ii is round; that of the external one of the first is cresentic; of the inner cusp, round. The heel is wide, and supports a cusp at the posterior external angle. It is bounded posteriorly, and on the inner side by a raised ridge, which gives with the cusp, on wearing a comma-shaped surface. A transverse ridge closely appressed to the anterior cusps connects them anteriorly. In one of the specimens there is a cingulum on the external side of the second inferior molar; on the other specimen it is wanting. Enamel smooth.

The mandibular ramus is rather deep and compressed, and displays an external ridge on the anterior border of the coronoid, which is not continued downwards.

Measurements (*No. 2*).		M.
Length of basis of true molars		.0125
Diameters M. ii	anteroposterior	.0040
	transverse	.0035
Depth of ramus at M. ii		.0073

From the Puerco beds of New Mexico. D. Baldwin.

Mioclænus subtrigonus Cope, Amer. Nat. 1881, p. 490, 491.
Mioclænus protogonioides Cope, loc. cit. 1882, Oct. (Sept.), p. 833.
Mioclænus mandibularis Cope, Amer. Nat. 1881, p. 830.
Mioclænus baldwini Cope, loc. cit. 1882, Oct. p. 833.

GENERAL REMARKS.

The preceding list of fifty-six species is doubtless sufficiently characteristic to enable us to form a pretty good idea of the Puerco fauna. Omitting six undetermined species of reptiles, we find the following peculiarities in the remaining forms. As already pointed out the three determined species of reptiles belong to a suborder, which has thus far been only found in the Laramie formation, or Cretaceous No. 6. This gives the Puerco at once a position below all the other tertiaries. The mutilate orders of mammals may be dismissed as being not likely to occur in a lacustrine formation. The orders of land Mammals are represented as follows:

Monotremata		0
Marsupialia		5
Rodentia		0
Chiroptera		0
Edentata		0
Bunotheria		15
	Tæniodonta	2
	Tillodonta	2
	Insectivora	0
	Mesodonta	2
	Lemuroidea	0
	Creodonta	9
Taxeopoda		25
	Hyracoidea	0
	Condylarthra	25
Proboscidea		0
Amblypoda		0
Diplarthra		0
Carnivora		0
Quadrumana		0
Total		45

The above list renders the peculiar facies of this fauna at once apparent. It is the only Tertiary fauna known, from which Perissodactyla are absent. The absence of Amblypoda, one of the oldest types, is unexpected. The lack of Rodentia is remarkable, and perhaps only due to failure of discovery; but if yet to be found, they must be very rare, and their absence is consistent with their small representation in the Wasatch beds above them. In the large number of Bunotheria, the Puerco agrees with the later Eocenes, but the order is here characterized by the small number of Mesodonta; and the Lemuroidea are apparently absent. An especial feature of the fauna is the presence of five undoubted species of Marsupialia of the family Plagiaulacidae, which has its origin in the Jurassic

period, and extended through the Cretaceous. It is represented in the latter period in the Laramie by the genus *Meniscoëssus.**

In the absence of a number of the existing orders of placental Mammalia, the Puerco agrees with other Eocene faunæ. In the absence of all of the placental orders with convoluted cerebral hemispheres, this fauna is more primitive than any other Eocene fauna. The absence of all ungulata excepting Taxeopoda, which have the most primitive foot structure, is further evidence of its primitive character. This is further increased by the presence of the Marsupialia above mentioned. The general result is a mixture of Marsupial, and semi-marsupial forms, with half lemurs, and a great expansion of the Hyracoid type.

In more detail, the genera of Bunotheria may be compared with those of the period immediately following; viz.: The Wasatch. One genus only of the Creodonta is common to the two epochs (*Didymictis*). Five of the species remaining are much like oppossums, and may be Marsupialia. The two genera (*Deltatherium* and *Triisodon*) to which they belong, do not occur in the Wasatch. The remaining two genera, (three species) are peculiar to the Puerco, but represent a family (Mesonychidæ) which occurs throughout our Eocenes. The two species of Mesodonta belong to genera of the Wasatch, one of them at least extending into the Bridger. The genera of Tæniodonta and Tillodonta are distinct from those of any of the later Eocenes, so far as known.

Supplement on a new Meniscotherium from the Wasatch epoch.

Meniscotherium tapiacitis, sp. nov.

The species now to be described is a good deal smaller than *M. chamense*, and, *a fortiori*, than the *M. terrærubræ*. It is known to me from the nearly entire rami of a single mandible. These support the last five molars of one side or the other, and alveoli of two others and of the canine tooth.

Two characters besides the small size, are observable in this jaw. First, the symphysis has not the shallow convex inferior outline in transverse section; but is on the contrary angular, having subvertical sides separated from a convex middle by a rounded angle. The symphysis is thus deeper than in *M. terrærubræ*. Second, the crown of the third inferior molar tooth has partly the form of that of the second of the *M. terrærubræ*. It is anteroposteriorly short, and has a short heel and no anterior basal lobe; the section of the principal lobe is lenticular, and profile subconic. In *M. terrærubræ* this tooth is elongate, with well developed heel and anterior lobe. The alveolus of the canine is relatively larger than that of the *M. terrærubræ*. The coronoid process does not rise so close to the last molar tooth, nor so steeply, as in the latter species. The posterior recurvature of the internal extremity of the anterior limb of the posterior V of the true molars is but little marked.

* American Naturalist, 1882, p 830, Sept, 28th.

Measurements.	M.
Length of true molars on base	.018
Diameters M. ii { anteroposterior	.006
Diameters M. ii { transverse	.0044
Diameters M. iii { anteroposterior	.0065
Diameters M. iii { transverse	.0038
Diameters P-m. iii { vertical	.0045
Diameters P-m. iii { anteroposterior	.004
Width of inferior face of symphysis	.008
Depth ramus at P-m. iii	.009
" " " M. iii	.0103

This species was obtained by Mr. D. Baldwin from beds of probably lowest Wasatch age, in New Mexico.

On the Systematic Relations of the Carnivora Fissipedia. By E. D. Cope.

(*Read before the American Philosophical Society, October 20, 1882.*)

This order embraces the clawed mammalia with transverse glenoid cavity of the squamosal bone, confluent scaphoid and lunar bones of the carpus, and well developed cerebral hemispheres. It is well distinguished from all others at present known, but such definition is likely to be invalidated by future discovery. Some of the Insectivora possess a united scapholunar bone, but the reduction of the cerebral hemispheres of such forms distinguishes them. The presence of the crucial fissure of the hemispheres is present under various modifications in all *Carnivora*, while the parietooccipital and calcarine fissures are absent.

The many types of existing carnivora fall into natural groups, which are of the grade termed family in zoölogy. But the distinction of these from each other is not easily accompanished, nor is it easy to express their relations in a satisfactory manner. The primary suborders of pinnipedia and fissipedia are easily defined. Various characters have been considered in ascertaining the taxonomy of the more numerous fissiped division. The characters of the teeth, especially the sectorials, are important, as is also the number of the digits. Turner* has added important characters derived from the foramina at the base of the skull, and the otic bulla, which Flower† has extended. Garrod‡ has pointed out the significance of the number of convolutions of the middle and posterior part of the hemispheres. I have added some characters derived from the foramina of the posterior and lateral walls of the skull.§ Mr. Turner also defines the families by the form and relations of the paroccipital process.

* Proceedings Zoological Soc., London, 1848, p. 63.
† Loc. cit., 1869, p. 5. ‡ Loc. cit., 1878, p. 377.
§ Proceedings Amer. Philosophical Society, 1880, p.

In studying the extinct carnivora of the Tertiary period, it has become necessary to examine into the above definitions, in order to determine the affinities of the numerous genera which have been discovered. To take them up in order, I begin with the foramina at the base of the skull. The result of my study of these has been, that their importance was not overrated by Mr. Turner, and that the divisions of secondary rank indicated by them are well founded. Secondly, as to the form and structure of the auditory bulla. Although the degree and form of inflation are characteristic of various groups of Carnivora, they cannot be used in a systematic sense, because like all characters of proportion merely, there is no way of expressing them in a tangible form. For, if the forms in question pass into each other, the gradations are *insensible*, and not sensible, as is the case with an organ composed of distinct parts. The same objection does not apply so much to the arrangement of the septa of the bulla. The septum is absent in the Arctoidea of Flower (*Ursidæ* of Turner), small in the Cynoidea (Flower, *Canidæ* Turner), and generally large in the Æluroidea (Flower, *Felidæ* Turner). But here occurs the serious discrepancy, that in the Hyænidæ, otherwise so nearly allied to the Felidæ, the septum of the bulla is wanting. Nevertheless, the serial arrangement of the order indicated by Flower, viz.: commencing with the Arctoidea, following with the Cynoidea, and ending with the Æluroidea, is generally sustained by the structure of the auditory bulla, and by the characters of the feet and dentition, as well as of the cranial foramina. Turner's arrangement in the order, Ursidæ, Felidæ and Canidæ, is not sustained by his own characters, and its only support is derived from Flower's observations on the external or sylvian convolution of the hemisphere of the brain.* There are three simple longitudinal convolutions in the raccoons; in the civets and cats the inferior convolution is fissured at the extremities, while in the dogs it is entirely divided, so that there are four longitudinal convolutions between the sylvian and median fissures.

An important set of characters hitherto overlooked, confirms Flower's order. I refer to those derived from the turbinal bones. In the ursine and canine forms generally, the maxilloturbinal is largely developed, and excludes the two ethmoturbinals from the anterior nareal opening. In the Feline group, as arranged by Turner, the inferior ethmoturbinal is developed at the expense of the maxilloturbinal, and occupies a part of the anterior nareal opening. These modifications are not, so far as my experience has gone, subject to the exceptions seen in the development of the otic septa and molar teeth, while they coincide with their indications. The seals possess the character of the inferior group, or Ursidæ, in a high degree.

The characters derived from the paroccipital process are of limited application, as the study of the extinct forms shows.

* Proceedings Zoological Society, London, 1869, p. 482.

I would then divide the fissiped carnivora into two tribes as follows:

External nostril occupied by the complex maxilloturbinal bone; ethmoturbinals confined to the posterior part of the nasal fossa; the inferior ethmoturbinal of reduced size.....HYPOMYCTERI.
External nostril occupied by the inferior ethmoturbinal and the reduced maxilloturbinal.....EPIMYCTERI.

While no doubt transitional forms will be discovered, the types at present known fall very distinctly into one or the other of these divisions. The characters are readily preceived on looking into the nares of well cleaned specimens. The *Hypomycteri* stand next to the *Pinnipedia*, since the maxilloturbinal bone has the same anterior development in that group.

In searching for definitions of the families, it is necessary to be precise as to the definition of terms. The meaning of the word sectorial is in this connection important, since there are so many transitional forms between the sectorial and tubercular tooth. A sectorial tooth then of the upper jaw, is one which has at least two external tubercles, which are the the homologues of the median and posterior lobes of the sectorial of the cat. By the flattening and emargination of their continuous edges, the sectorial blade is formed. One or two interior, and an anterior lobe, may or may not exist. In the genera of the *Procyonidæ*, except in *Bassaris*, the two external tubercles do not form a blade. The inferior sectorial tooth differs from the tubercular only in having an anterior lobe or cusp, which belongs primitively to the interior side. The inferior sectorial teeth with large heels, as in Viverridæ and Canidæ, I have called tubercular-sectorials. The sectorial blade is formed by the union and emargination of the edges of the anterior and the principal external cusp. This blade is not well developed in the genus *Cynogale* and still less in the *Procyonidæ* and *Ursidæ*. The families are then defined as follows.

HYPOMYCTERI.

I. No sectorial teeth in either jaw.

Toes 5–5.....*Cercoleptidæ*.

II. Sectorial teeth in both jaws.

a. Toes 5–5

β. No alisphenoid canal.

True molars $\frac{2}{2}$.....*Procyonidæ*.
" " $\frac{1}{2}$.....*Mustelidæ*.

ββ. An alisphenoid canal.

Molars quadrate, $\frac{2}{2}$.....*Aeluridæ*.
Molars longitudinal, $\frac{2}{3}$.....*Ursidæ*.

aa. Toes 5–4 or 4–4.

Sectorials well developed, an alisphenoid canal.....*Canidæ*.

EPIMYCTERI.

I. Molars haplodont.

Toes 5–4; no alisphenoid canal..... .....*Protelidæ.*

II. Molars bunodont, no sectorials.

Toes 5–5; an alisphenoid canal.....*Arctictidæ.*

III. Molars bunodont, with sectorials.

a. Otic bulla with septum.

β. Alisphenoid canal and postglenoid foramen, present.

γ. True molars well developed.

Toes 5–5..... .....*Viverridæ.*

Toes 5–4.....*Cynictidæ.*

Toes 4–4.....*Suricatidæ.*

γγ. True molars much reduced.

Toes 5–5..... .....*Cryptoproctidæ.*

Toes 5–4.....*Nimravidæ.*

ββ. No alisphenoid canal; post glenoid foramen rudimental or wanting.

Toes 5–4..... .....*Felidæ.*

aa Otic bulla without septum.

No alisphenoid canal, nor post glenoid foramen: Toes 4–4.....*Hyænidæ.*

The genera of these families are the following:

CERCOLEPTIDÆ; *Cercoleptes* Neotropical.

PROCYONIDÆ; *Procyon,* Bassaricyon, Bassaris;* Nearctic and Neotropical.

MUSTELIDÆ; Melinæ (two tubercles of internal side of superior sectorial); *Taxidea, Meles.* Mustelinæ, (one internal tubercle of superior sectorials); *Enhydris, Pteronura, Lutra, Aonyx, Barangia; Helictis, Zorilla, Mephitis, Conepatus; Mellivora; Gulo, Galictis, Putorius, Mustela.*

ÆLURIDÆ; *Aelurus; Æluropoda ? Hyænarctos.*

URSIDÆ; *Helarctos; Arctotherium; Ursus; Melursus.*

CANIDÆ; *Megalotis†; Amphicyon; Thous, Palæocyon, Temnocyon, Galecynus, Canis, Vulpes, Enhydrocyon, Hyænocyon, Brachycyon, Tomarctus, Speothus, Synagodus, Dysodus, Oligobunis, Icticyon, Lycaon.*

PROTELIDÆ; *Proteles.* Ethiopian.

ARCTICTIDÆ; *Arctictis.* Indian.

VIVERRIDÆ; *Cynogale, Arctogale, Paguma, Paradoxurus, Nandinia, Hemigale, Galidia, Prionodon, Genetta, Viverricula, Viverra, Galidictis, Herpestes, Athylax, Calogale, Ichneumia, Bdeogale, Urva, Tæniogale, Onychogale, Helogale, Rhinogale, Mungos, Crossarchus, Eupleres.*

CYNICTIDÆ; *Cynictis, ? Ictitherium.*

SURICATIDÆ; *Suricata;* Ethiopia.

CRYPTOPROCTIDÆ; *Prælurus; Cryptoprocta.*

NIMRAVIDÆ; *Archælurus, Nimravus, Ælurogale; Dinictis, Pogonodon, Hoplophoneus.*

* Including *Nasua*, which is not distinct.

† This genus cannot be made the type of a family as is done by Dr. Gray.

FELIDÆ; Machærodontinæ; *Machærodus, Smilodon;* Felinæ; *Plethælurus* (g. n.)*, *Catolynx; Felis; Neofelis; Uncia,*† *Lynx, Cynælurus.*
HYÆNIDÆ, *Hyænictis, Hyæna, Crocuta.*

Stated Meeting, Oct. 6th, 1882.

Present, 12 members.

Dr. CRESSON in the Chair.

Letters of acknowledgment were received from the Royal Society, Tasmania (90, 91), and the Surgeon General's Office, Washington (110, 111).

Letters of envoy were received from the Meteorological Office, London; and the University Library, Cambridge, England.

A request for missing numbers in the set of the American Philosophical Society Transactions and Proceedings in the library of the Geological Survey of Canada, was referred to the Librarian to report at the next meeting.

Donations for the Library were received from the Academies at St. Petersburg, Amsterdam, Turin, and Rome; Swedish Bureau of Statistics; Christiania University; Royal Danish Society; Royal Observatory, Turin; Zoologischer Anzeiger, Leipsig; Revue Politique, Paris; Meteorological Council, and Nature, London; Geological Society, Glasgow; M. Douw Lightfall, Montreal; Natural History Society, Boston; American Antiquarian Society, Worcester; American Philological Association; Free Public Library, New Bedford; American Journal, New Haven; N. Y. Meteorological Observatory; Buffalo Society of Natural Sciences; E. M. Museum of Geology and Archæology, Princeton; Franklin Institute, College of Pharmacy, Pennsylvania Museum of Industrial Art, and E. A.

* Type, *Felis planiceps* vig. Horsf. Char. Second (first) superior premolar two rooted; orbit closed behind; pupil round.

† Mr. Wortman has called my attention to a character of this genus which confirms its separation from Felis, as I proposed in 1879. The maxilloturbinal bone is less complex in the genus Uncia, than in Felis, consistently with a less nocturnal habit, and less necessity for acute smell.

Barber, Philadelphia; Delaware Historical Society; U. S. Naval Observatory, Census Bureau, U. S. National Museum and Fish Commission, Washington, D. C.

The death of S. F. Haven, at Worcester, Mass., in Sept. 1881, was ordered to be placed on record.

The death of Robert Briggs, at Dedham, Mass., July 25, 1882, aged about 55, was ordered to be placed on record.

Mr. Lewis read a paper on the Terminal Moraine in Pennsylvania.

Mr. Chase communicated a sixth series of Photodynamic notes.

Mr. Cope described a new synthetic form of Laramie Cretaceous mammal, *Meniscoëssus conquistus*, the first mammal species discovered in the Cretaceous.

Nominations 964–968 were read, and the meeting was adjourned.

Stated Meeting, Oct. 20th, 1882.

Present, 12 members.

Mr. FRALEY, President, in the Chair.

Rev. Dr. Robbins was introduced to the presiding officer and took his seat.

Letters of envoy were received from the New Zealand Museum, Howard Coll. Observatory, the N. H. S. at Bamberg, and the Dept. Int. U. S.

A letter acknowledging Proc. No. 109, was received from the Danish S. of Sciences.

A letter from Mr. Jos. D. Weeks, of the Census office, Washington, requesting No. 87, was received.

A letter from Mr. A. Ramsay, office of the Scientific Roll, 7 Red Lion Court, Fleet street, London, requesting exchanges was received, dated Oct. 5th, 1882.

A letter from the "American" was read.

A letter from the Department of the Interior was received,

respecting spare copies of the Census Reports of 1860 and 1870.

Donations for the Library were announced from the New Zealand Institute; Sydney Department of Mines; M. Barrande; Aug. Tischner; L. Rütimeyer; the N. H. S., Bamberg; the Gazetta Numismatica, at Como; Revue Politique; Revista Euskara; London Nature, C. W. King and C. Piazzi Smyth; the Massachusetts Historical Society; Harvard College Observatory; N. J. Historical Society; Pennsylvania Historical Society; Journal Medical Sciences; Smithsonian Institution; U. S. Geological and Geographical Survey, Signal Service and Census Bureaus, and Surgeon General's office; University of Virginia; American Journal of Forestry at Cincinnati; American Antiquarian at Chicago; Mexican National Observatory, and a copy of Herrera in four volumes from the library of the late Dr. Allen Voorhees Lesley, of New Castle, Del.

The death of Mr. John Downes at Washington, Sept. 27th, aged 84, was announced by the Secretary.

The death of Dr. Friédrich Wöhler, of Göttingen, Sept. 23d, aged 82, was announced by letter.

Dr. Horatio C. Wood offered for publication in the Transactions a memoir, entitled "On the nature of Diphtheria, a clinical and experimental research, by Drs. H. C. Wood and H. F. Forncad."

On motion it was referred for examination to a committee consisting of Drs. Horn, Ruschenberger and Henry Hartshorne.

Commodore E. Y. McCauley offered for publication in the Transactions a Dictionary of the Egyptian language.

On motion it was referred for examination to a committee consisting of Mr. Lesley, Dr. LeConte, Dr. Robbins and Mr. Phillips.

Prof. I. C. White's communication on the Geology of the Cheat river, in West Virginia, was read by the Secretary.

Prof. C. W. Claypole's notes on the Commingling of fossil forms, the discovery of *Holoptychius Americanus* low in the Chemung, at Leroy, in Bradford Co., Pa., and on a mistake in

the Geological map of Bradford Co., were read by the Secretary.

Mr. Lesley described some recent observations of the amount of ice erosion along the crest of the Kittatinny mountain, west of the Delaware Water Gap, by Prof. H. C. Lewis.

Prof. Cope communicated a catalogue of twenty-eight new species entitled "Synopsis of the Vertebrata of the Puerco Eocene epoch," and a paper "On the systematic relations of the Carnivora."

On motion the deficiencies in the set of American Philosophical Society in the library of the Geological Survey of Canada were ordered to be supplied.

On motion of Mr. Phillips the President was requested to prepare a minute of the Bi-Centennial Celebration of the settlement of Pennsylvania, to be embodied in the records of the Society.

Pending nominations Nos. 964 to 968 were read and balloted for, and new nomination No. 968 was read.

On examination of the ballot boxes by the presiding officer, the following were declared duly elected members of the Society:

Charles Rau, M. D., Curator U. S. Museum, Washington.
Garrick Mallery, Lieutenant-Colonel U. S. A.
Hermann Kopp, of Heidelberg University.
Reinhardt Blum, of Heidelberg University.
Gustaf Tschermak, Director Geol. Reichsanstalt, Vienna.

And the meeting was adjourned.

Notes on the Geology of West Virginia. By I. C. White.

(Read before the American Philosophical Society, October 20, 1882.)

The Geology of the Cheat river Cañon along its course through Laurel Hill and Chestnut Ridge, between Albright (near Kingwood), in Preston county, and Ice's Ferry, in Monongalia county.

The material for the present paper has been gradually accumulated on class excursions from the University during the last five years.

Cheat river takes its rise on the summit of that great plateau, near the Randolph-Pocahontas line, from which so many large streams radiate to every point of the compass, the Elk, Greenbrier, James, Potomac, Monongahela and Cheat, all having the source of their principal branches on this plateau at an altitude of more than 3000 feet above the sea.

From this elevated divide, several branches—Dry, Laurel, Globe and Shaver's—flow northward in narrow, parallel valleys, into the southern portion of Tucker county, where meeting Black Fork from the north-east, they unite to form the main Cheat river which with many windings continues its general course almost due north to Albright, the south-eastern limit of the district under examination. Here, however, it veers to the north-west and maintains that general direction for the next twenty-five miles to Ice's Ferry, in Monongalia county, where it again veers north and unites with the Monongahela river just north from the W. Va.-Penna. line.

At Albright, the channel of the river is in the bottom of the syncline between the Viaduct and Laurel Hill axes, and its north-west course for twenty-five miles carries it squarely through Laurel Hill, Chestnut Ridge and the great synclinal plateau between them. Throughout this twenty miles (about twenty-five by the river), Cheat river flows in a wild cañon cut down 1000′–1500′ below the summits of the bordering mountains whose slopes are so rocky and precipitous that but a single human dwelling is in sight along the river, from where one enters the cañon below Albright, until he emerges from it near Ice's Ferry.

The Great Conglomerate, or No. XII, carrying the *Lower Coal Measures* on its top, crowns the steepest portion of the cañon throughout its entire length, and its immense boulders constantly block the narrow channel of the river, thus giving a wildness and grandeur to the scenery unsurpassed anywhere along the course of this famous stream.

But unrivaled as is the scenic beauty of this cañon, it presents still greater attractions for the geologist in the splendid natural exposures of the *Great Conglomerate* and *Sub-carboniferous* rocks that it affords; for under the arches of Laurel and Chestnut Ridges one may find many almost clean exposures from the top of No. XII down nearly to the base of No. X. To place some of these magnificent sections before those interested in Carboniferous geology is the principal object of this paper, and in order to accomplish this systematically we shall begin with the section at Ice's Ferry, and pass south-eastward up the Cheat river to Albright.

At this ferry, the road leading from Morgantown, W. Va., to Uniontown, Pa., crosses the river which, emerging from the cañon of No. XII, one mile above, now flows between low hills of the *Barren measures* with the *Mahoning sandstone* making bold cliffs along the immediate banks

About one-fourth mile above the ferry, a small stream puts into the west bank of Cheat over the Mahoning sandstone cliffs, and descending it from the Morgantown road near Mr. Bayles, the following succession may be seen, Sec. 1:

1. *Coal (crinoidal)*..... 1′
2. Shales, gray..... .....10′
3. *Shales, red*.....25′
4. Shales and concealed.....45′
5. Shales, brown, sandy.....10′
6. *Coal, Bakerstown*..... 2′½
7. Sandy shales and shaly sandstone.....50′
8. *Upper Mahoning sandstone*, very massive and pebbly..30′
9. Shaly sandstone, intermingled with *slaty coal* and representing *Brush creek coal* of Pennsylvania.... 3′
10. Sandy Shales..... 7′
11. *Lower Mahoning sandstone*, visible.....85′
12. Concealed to level of Cheat river.....10′

No. 1 is the coal which so frequently occurs directly under the *Green Crinoidal limestone* in south-west Pennsylvania and the adjoining regions in West Virginia. It is quite impure and is well exposed at the roadside, some distance north-west from Mr. Bayles'.

No. 3 is the very persistent bed of red, marly shales which so constantly underlie the *Crinoidal limestone* in Pennsylvania and West Virginia, even retaining their place unfailingly in the series when the latter disappears.

The Bakerstown coal, No. 6, occurs along the Morgantown road near the toll-gate at Mr. Bayles', and is of fair quality. I have identified it with the coal bed occurring 100′ below the *Crinoidal limestone*, described as the *Bakerstown coal* in my Report Q, on North Allegheny county, Pennsylvania. These coals of the *Barrens* are of course sporadic and irregular in distribution, and their identification over wide areas would seem at first thought hazardous in the extreme, but as the principal beds always come in at certain well defined stratigraphical horizons there can be less objection to such identification than to a constant multiplication of local names to represent the same geological horizon, hence as the coal in question comes about 100′ below the *Crinoidal limestone*, I have thought it preferable to use the *Bakerstown* name even though the coal marshes in which each was formed may never have been connected with one another.

The Upper Mahoning sandstone, No. 8, is very conglomeratic at this locality, so much so that it was once extensively quarried for mill stones on the opposite side of the river.

The Brush creek coal is feebly represented in the section by a bed of black *coal slate* interstratified with thin layers of sandstone, immediately under the *Upper Mahoning sandstone*.

The Lower Mahoning Sandstone is not pebbly at this locality, and is rather inclined to be flaggy, though some portions of it are quite massive.

The Upper Freeport coal lies about 10′ below the level of Cheat river at the mouth of Bayles' run, where our section ends. On the east bank of the stream, it rises above drainage and was once mined as fuel for the Laurel Iron Works, situated one-half mile below. The coal is reported four feet thick and of good quality.

In passing up the river south-eastward from the ferry, the rocks rise very rapidly toward the *Chestnut Ridge axis*, and the top of No. XII makes its appearance above river level in a massive dam-like wall, just below Mr. Ley's, and not quite a mile above the ferry.

The intervening *Lower Coal Measures* are not well exposed, being concealed by the immense heaps of talus under the cliffs of Mahoning sandstone, but a vertical measurement from the outcrop of the *Upper Freeport coal* where seen along the Bruceton turnpike opposite Mr. Ley's, down to the top of the No. XII Conglomerate makes their thickness 250′. The only *coals* in these measures here are the *Upper Freeport*, and one that comes about 160′ below it, being 1½′–2′ thick, and very excellent coal. It is either the *Middle* or *Lower Kittanning*, most probably the latter.

Continuing on up the river above Mr. Ley's, the rocks rise about 400′–450′ to the mile, and bring the top of the *Mauch Chunk shales* (No. XI) above river level at the mouth of Quarry run, a small stream that empties into the east bank of Cheat, one mile and a half above Ice's Ferry. It cuts a fine exposure through No. XII and in descending to the river along its right bank this section was got, Sec. 2:

1. Sandstone, massive, *Homewood*, top of XII		25′	Pottsville conglomerate.
2. Concealed		40′	
3. Very massive pebbly sandstone		75′	
4. *Coal*	coal 0′ 10″ sandstone 0′ 3″ coal 0′ 3″	*Quakertown coal?* 1′ 4″	
		177′	
5. Black, slaty shale		10′	
6. Sandstone, gray, massive		20′	
7. *Shale with streaks of coal*		1′	
8. Sandstone, grayish-white, massive, base of No. XII		15′	
9. Shales, green, containing I. O., top of No. XI		20′	Mauch Chunk Shales.
10. *Red shales*		10′	
11. Greenish sandy shales and flaggy sandstone		60′	
		30′	
12. Concealed to mouth of old oil well boring		25′	
13. Flaggy sandstone and shales (Mr. Ley's authority) in oil boring		185′	
14. *Limestone, Umbral, Mountain, &c*		85′	
15. Sandstone, (*Vespertine*, No. X) to bottom of hole		700′	

The section of No. XII, obtained at this locality, is quite interesting from the fact that it reveals this series much thinner than it had always been estimated on Cheat river. Owing to the difficulty of finding exposures at the immediate base of No. XII, much of the underlying massive rock in the Mauch Chunk shales has heretofore been included in No. XII on Cheat river, thus giving it a thickness of 300′–350′. The above section shows the true base of No. XII in an unmistakable manner, and shows that this series has a thickness of only 180′ at the locality in question.

The uppermost member, No. I, which corresponds to the *Homewood SS.* of the Penna. Survey reports, is a very massive, grayish-white rock, making a bold cliff around the mountain side, 20 to 30 yards back from No. 3, from which it is separated by a concealed interval of 40′ at this locality. This No. 2 is probably a shale or flaggy sandstone interval and may possibly contain a small coal bed, since the *Mercer series* of Penna. is due in this horizon.

No. 3 is the conglomerate portion of No. XII and is seen in one immense overhanging cliff along the right bank of Quarry run. It is a grayish-white rock, often exhibiting a buffish tinge, and contains many quartz pebbles scattered in layers throughout its mass, being largest and most numerous in the uppermost 25′. None were seen larger than chestnuts.

This stratum would seem to harmonize with the *Upper Connoquenessing sandstone* of the *Conglomerate series* in western Pennsylvania. It is the great cliff rock along the Cheat river cañon.

Immediately below this last stratum, there comes a very interesting little *bed of coal* which is quite persistent for many miles along Cheat river, being generally separated into two layers by a thin sandstone or shale as shown in the section, and always underlain by a thick bed of black, fissile slate. The bed is fully exposed for a distance of 200 yards at the base of the great cliff along Quarry run, and its variations are there beautifully shown. Occasionally the sandstone comes down and cuts it out entirely for a few feet, but it suddenly comes in again at the same horizon. It never gets thicker than 2′ and seems to be quite pure, simulating the "block" coals in physical aspect. Since it appears to come at the same geological horizon as the *Quakertown coal* of Lawrence Co., Pennsylvania. I have doubtfully referred it to that bed.

A diligent search was made in the *black shale*, No. 5, for *fossil plants*, but as yet none have been found except some macerated fragments of *Cordaites*.

Nos. 6–8 seem to represent the *Lower Connoquenessing SS.* of Penna.; the older, *Sharon conglomerate*, being in my opinion unrepresented in the section.

In passing from No. XII to the rocks of XI, there is a wonderful change in the lithology of the rocks, the massive, coarse, grayish white beds of

XII being replaced by a green sandy shale which the geologist instantly recognizes as belonging in the subcarboniferous beds. The junction of XII and XI is finely exposed for several rods at this locality, and the former seems to rest with a *slight unconformity* on No. XI. In the top of No. XI, at the horizon of No. 9, occur valuable deposits of *iron ore* all along the Cheat river mountains on each side of Chestnut Ridge, and they were formerly extensively mined and used at the Henry Clay, Laurel, Green Spring and other furnaces. It is known as the "*Swisher*," and "*Mountain*" *ore*, and was mined by both drifting and stripping, the bed sometimes attaining a thickness of 2 feet.

Were there any doubt about No. 9's being the top of XI, No. 10 would resolve it, for *red shale* is a factor unknown in No. XII. This *red bed* seems to hold a constant place in the *Mauch Chunk series* along Cheat river, having been seen at this same horizon in many localities. The section from No. 13 down, was given me by Mr. Ley, who assisted in drilling a well for oil near the mouth of Quarry run. As will be seen from the section, it makes the *Mauch Chunk shale* 300′ thick, and the Mountain Limestone 85′.

No. 15, is very probably not all No. X, but the lower portion doubtless penetrates the *Catskill*, or *Chemung*, if the former be absent as Prof. Stevenson claims.

In passing up Cheat river from the mouth of Quarry run, the rocks rise quite rapidly, and at one-half mile south-east from the locality of the last section, all of the *Mauch Chunk shale*, and nearly half of the *Mountain Limestone* have appeared above water-level, where on the left bank of Cheat, they reveal this succession (Sec. 3):

1. Sandstone, current-bedded	10′	Mauch Chunk Shale.
2. Concealed	15′	
3. Red shale	10′	
4. *Limestone*, fossiliferous, impure	8′	
5. Shales, red and green	15′	
6. Shales, marly	5′	
7. Limestone, grayish-white, massive	25′	Mountain Limestone.
8. Shale, calcareous, very fossiliferous	1′	
9. Limestone, massive, gray to level of Cheat river (850′ A. T. by Bar)	15′	

This little section is interesting from the fact that it exhibits a structure in the basal portion of the *Mauch Chunk shale*, which is quite common in Fayette and Westmoreland counties. In those counties Prof. Stevenson (see Repts. KK, and KKK 2d Geol. Survey of Pa.), finds *one* and sometimes *two thin limestones* several feet above the base of the *Mauch Chunk shale*, and the same feature is present all along the Cheat river Cañon, as far up as Rowlesburg at least, where I find *three thin limestones* within an interval of 70′ *above the Mountain Limestone*. (See The Virginias for July, 1882.)

PROC. AMER. PHILOS. SOC. XX. 112. 3I. PRINTED NOVEMBER 20, 1882.

The *limestone*, No. 4, of the above section, is quite impure, having a brecciated appearance, and is fossiliferous, *Spirifers* and *Producti* being especially numerous. No. 7 was once extensively quarried at this locality, and used for flux at the old charcoal furnaces near Ice's Ferry. It is quite pure, making a beautiful white lime much valued for plastering purposes. It is possible that some portions of the stone might be successfully employed as a flux in the manufacture of glass.

The thin calcareous shale, No. 8, is a perfect mass of fossils, among which *Allorisma clavata*, *Hemipronites crassus*, *Athyris subtilita*, *A. subquadrata*, *Spirifer Keokuk*, *Productus cora*, and *Crinoidal fragments* are most numerous.

Continuing south-eastwards up the river, the rocks still rise with great rapidity, and at one mile and a half above the last locality, only 2½ miles from where the top of No. XII first emerges from the bed of Cheat, we get the following succession in descending the almost vertical wall on the right bank of the river (Sec. 4):

1.	Very massive pebbly sandstone	20′	
2.	Concealed	80′	No. XII.
3.	Sandstone, massive, coarse	20′	165′
4.	Concealed	45′	
5.	Shales and concealed	20′	Mauch Chunk shale.
6.	*Red shale*	10′	
7.	Sandstone, greenish, current-bedded	165′	
8.	*Red*, and green shales and concealed	50′	295′
9.	*Limestone*, impure	10′	
10.	Shales, green and red	25′	
11.	Flaggy sandstone and shales	15′	
12.	*Mountain limestone*, in layers 1′–10′ thick separated by thin calcareous shales	95′	
13.	Sandstone, finely laminated, and containing *pebbles of limestone*	10′	
14.	"Silicious limestone," grayish-white	5′	No. X.
15.	Sandstone, flaggy	10′	305′
16.	Sandstone, massive, pebbly, current-bedded	80′	
17.	Concealed to level of Cheat river (875 A. T.)	200′	

I have placed the base of No. XII in this section, 45′ below the top of the concealed interval, since the band of *red shale*, No. 6, is evidently identical with the one in Sec. 2, which comes 20′ below the base of XII. This gives a thickness of 165′ for the latter at this locality, and since 10′–15′ have been eroded from its top, the group when complete would have about the same thickness as found in Sec. 2 (177′).

The *Mauch Chunk shale* foots up a thickness of 295′ at this locality, which is so near that given by the combined section and boring in Sec. 2 (300′), that the latter figure may be taken as the average thickness of these

beds along the Cheat river cañon through Chestnut Ridge and Laurel Hill.

The sandstone in No. 7 gets quite massive at times, and this portion of the column makes a great bluff along either bank of the river, from which the descent to the stream is almost vertical in many places.

As will be seen by comparing the sections, the interval between the *Mountain limestone* and the *10′ impure limestone* above, is in this section just double that in Sec. 3, showing that it is quite variable.

The *Mountain limestone*, No. 12, juts out of the bluff in a great cliff at this point, and was once quarried for flux for the old Henry Clay furnace, situated near the head of Quarry run.

No. 14 seems to be identical with the "Silicious limestone" of Stevenson in Fayette and Westmoreland counties, and is here clearly a portion of No. X, since 10′ of *Pocono* or *Vespertine sandstone* comes above it.

No. 16 is a massive, hard, gray sandstone, containing streaks of small quartz pebbles, and forming an immense cliff along the mountain side.

About one-fourth mile above the last locality, another section taken on the same (east) bank of Cheat river reveals the following structure (Sec. 5):

1.	Massive sandstone, and conglomerate, making lower half of No. XII	100′	
2.	Concealed	50′	Mauch Chunk? 292′ shale.
3.	Sandstone, flaggy, and current-bedded	160′	
4.	Layer of breccia	2′	
5.	Concealed and red shale	40′	
6.	*Limestone*, impure	5′	
7.	*Red shale*, and concealed	35′	
8.	*Mountain limestone*, visible	85′	
9.	Concealed	25′	
10.	*"Silicious limestone,"*	10′	No. X 435′
11.	Sandstone, massive, pebbly	100′	
12.	Concealed with flaggy sandstone at base	175′	
13.	Concealed to Cheat river (885′ A. T.)	150′	

This section is but a repetition of the preceding one, with slight variations, the *Silicious limestone* being here 10′ thick instead of 5′. It is a light gray rock, containing possibly 40–50 per cent. of lime, and would make as good pavement blocks as that from Westmoreland Co., so extensively used in Pittsburgh and vicinity.

No. 4 is a curious layer of shale, iron ore, and sandstone pebbles cemented into a matrix of impure limestone.

The rocks still rise quite rapidly south-eastward as we approach the *Chestnut Ridge axis* which crosses Cheat river about one mile and a quarter above the locality of Sec. 5.

About one-half mile south-east from the locality of the last section, a small rivulet falls over the base of No. XII, and completely exposes the

beds at the junction of No. XI, with the former, exhibiting the following in descending the steep east bluff of the river (Sec. 6):

1.	Conglomerate, very massive	100′	No. XII. 180′
2.	Sandstone, coarse, few pebbles	50′	
3.	Shales, sandy, buff, containing some I. O.	20′	
4.	Sandstone, massive, buff	10′	
5.	Shales, yellow, and green, containing I. O.	30′	Mauch Chunk shale. 293′
6.	Sandstone, greenish, somewhat flaggy	140′	
7.	*Layer of breccia*, calcareous	2′	
8.	Sandstone, green, flaggy	20′	
9.	*Layer of breccia*, calcareous	1′	
10.	Shales, red and green	45′	
11.	*Limestone*, impure	10′	
12.	*Red shales*, and flaggy sandstone	45′	
13.	*Mountain limestone*	100′	
14.	"*Silicious limestone*," and Pocono sandstone	125′	No. X 575′
15.	Concealed to level of Cheat river	450′	

I was at first disposed to place the line between Nos. XII and XI at the base of No. 2 in the above section, but the massive yellowish sandstone, No. 4, so unlike anything usually found in No. XI, determined its base as the true dividing horizon between the two series. This is also confirmed by the thicknesses which result from placing it there, viz.: 180′ for XII and 293′ for XI shales, which are almost exactly the same as found for each in Sec. 2.

The "*Silicious limestone*" is 10′–15′ thick at this locality and as usual passes insensibly into the great sandstone deposit below.

A few rods further south from the last locality another measurement of the beds gave this result (Sec. 7):

1.	Massive, pebbly sandstone	150′	No. XII. 185′.
2.	Shales and shaly sandstone, buff	35′	
3.	Shales, greenish, sandy	30′	Mauch Chunk Shale. 299′
4.	Sandstone, greenish-gray, flaggy	90′	
5.	*Red and green shales*	12′	
6.	Sandstone, greenish, massive at top, flaggy and shaly below	65′	
7.	*Brecciated limestone*	2′	
8.	*Red and green shales*	25′	
9.	Blue sandy shales, and green flaggy SS.	25′	
10.	*Limestone*, impure, fossiliferous	10′	
11.	Red and green shales and sandstone	40′	
12.	*Mountain Limestone*		

(*a*.) Massive limestone in layers 1′—5′ thick, sparingly fossiliferous	25′	110′
(*b*). Shaly limestone and calcareous shales, very fossiliferous, especially rich in *Productus, Spirifer, Athyris, Lophophyllum and Crinoidal columns*	5′	
(*c*). *Limestone*, gray, good, few fossils	45′	
(*d*). Shales and limestone	35′	
13. "*Silicious limestone*," passing gradually into sandstone below	30′	No. X. 605.
14. Sandstone, massive, pebbly, current-bedded, making cliffs	100′	
15. Concealed to level of Cheat river	475′	

Here the "*Silicious limestone*" runs down into the underlying sandstone to a depth of 30′ and finally fades into sandstone so imperceptibly that it is impossible to fix the line between the two.

Just above this locality, about one-fourth mile, the *Chestnut Ridge axis* crosses Cheat river, four and a half miles from Ice's Ferry. At the latter locality the top of No XII. is 300′ under the river, while here at the axis its top comes about 1300′ above Cheat river, or 1400′ higher than at Ice's Ferry, since the stream falls nearly 100′ between the two points.

Here, at the crest of the axis, the Great Conglomerate makes a broad and gentle arch, being almost horizontal for nearly a mile and a half. Its outcrop is traversed as usual by great intersecting fissures which are often 3′—4′ wide, and separate the stratum into immense blocks, some of which 50′ on a side, have toppled over into the steeply sloping edge of the cañon, and look from a distance as though a slight push would dislodge them into the great chasm beneath.

The scenery along the crest of this great arch is the grandest and most picturesque to be found on this river, famous for its wildness for a distance of nearly 200 miles. There are two points from which the outlook is especially fine, one of these known as *Hanging Cliff View* is on the east side of the river and about one mile above the locality of the last section. Here the river bends sharply westward and a long, narrow ledge of No. XII. sandstone, extends in a bold cliff far out into the main course of the cañon. From this elevated point, the eye takes in a radius of 25 to 30 miles for nearly three-quarters of the horizon; to the south-east one looks up through the great gorges carved by the river out of Laurel Hill and Briery mountain, to the vicinity of Rowlesburg (30 miles distant), where on a clear day, the white puffs of steam and smoke from the B. & O. R. R. engines may be distinctly seen, as the heavily laden trains wind up the steep slopes of the Alleghanies to Cranberry Summit, the lofty peaks of whose surrounding mountains loom proudly against the horizon; to the west and north, the eye has an unobstructed view down the cañon and out over its fast receding walls, to the great plateau of the

Coal Measures, which sculptured into endless forms of hill and dale stretches away to the limit of vision, in delightful contrast to the rugged mountains on the east. Add to this the wild dash of the river as it rushes along over its rocky bed, more than a thousand feet almost vertically below, disappearing in a silver thread far up and down the cañon, and we have a picture enchanting in the extreme.

The other point is Brock's View, named in honor of the late Dr. H. W. Brock, of the W. Va. University, who first discovered the beauties of this portion of the cañon. It is on the opposite side of the river from the Hanging Cliff, nearly one mile below, and is scarcely inferior in grandeur to the latter.

In descending from Hanging Cliff View to the river the following structure is visible (Sec. 8):

1. Massive conglomerate	75′	No. XII 185′
2. Concealed to base of XII	110′	
3. Concealed	190′	Mauch Chunk 300′ Shale.
4. Shales, red, green, &c., containing an impure limestone just below the centre	100′	
5. Sandstone, greenish-gray, current-bedded	10′	
6. *Mountain Limestone*	95′	
7. Concealed, with occasional showing of limestone and shales	60′	
8. Concealed to level of Cheat river	425′	

In descending from the same Hanging Cliff to a point one-half mile further up the river, and just below the "Beaver Hole," the following succession was observed (Sec. 9):

1. Massive conglomerate, visible	65′	No. XII 185′
2. Concealed to base of No XII	120′	
3. Concealed	60′	Mauch Chunk 295′ Shale.
4. Sandstone, green, flaggy	25′	
5. Concealed, but showing frequent outcrops of green, flaggy sandstone	195′	
6. Sandstone, green, massive, visible	5′	
7. Concealed	10′	
8. *Mountain Limestone*	120′	
9. *"Siliceous Limestone"*	30′	
10. *Pocono sandstone*, massive and pebbly at top, hard and flaggy below to the level of Cheat river	425′	

The *Mountain Limestone* contains some extensive caverns along Cheat river, and one not far from the locality of this section has been named the *Eagle Cave*, from the fancied resemblance of one of its stalagmitic accumulations to the outspread figure of an eagle. It has been followed into the mountain side for several hundred yards, and those who have explored it, report some extensive rooms in this cavern.

The "Beaver Hole" mentioned above is a locality just above the Hanging Cliff View, where the current of the stream flows around the circumference of a circle about 150 yards in diameter, and is six miles above Ice's Ferry by the river, but probably not more than five in a direct line.

Continuing up the river from this point toward the south-east, the rocks dip rapidly down, and when we come to the mouth of Sandy creek, four miles above the Beaver Hole, the top of No. XII is only 400′ above the level of the stream, instead of 1300′, at the crest of the Chestnut Ridge axis. Here at the mouth of Sandy creek we are in the centre of the great trough or syncline between the Chestnut Ridge and Laurel Hill axes. This syncline enters Preston county from Fayette county, Pa., and extends in a south-west course entirely across Preston. The trough is about seven miles wide (from Chestnut Ridge axis to Laurel Hill axis) on Cheat river, but opens out rapidly south-westward from the dying down of its western rim (Chestnut Ridge axis), so that at the B. & O. R.R., near Independence, its breadth is not far from 12 miles.

The *Lower Coal Measures* shoot into the air on Chestnut ridge, but arching over, come down into this Preston county syncline, with 200 to 300 feet of the *Barrens* on top of them, so that at the mouth of Sandy creek, the *Upper Freeport Coal* comes into the immediate river hills. Sandy creek flows down the centre of the syncline from the east, removing a large portion of the *Barrens*, and near its mouth cutting a wide gap in the *Lower Coal Measures*, and a narrow gorge through No. XII.

In the same way, Bull run flows down the central line of the syncline from the west, emptying into Cheat one-half mile below the mouth of Sandy. It, too, has eroded a large hole from the *Lower Coal Measures*, but on cutting down to No. XII is suddenly arrested, and flows along on its top for nearly a mile until approaching the river, it cuts through the massive beds of that series, in several great cascades, giving splendid exposures of the rocks.

In descending the mountain from Mrs. Spurgeon's (opposite the mouth of Sandy creek), to Bull run, and thence down that stream to Cheat river, the following section (10) was constructed:

1.	Upper Mahoning Sandstone, massive, visible		20′	
2.	Concealed (spring at 50′)		90′	
3.	*Upper Freeport Coal*	coal, slaty	1′ 0″	7′
		coal, good	2′ 0″	
		shale	0′ 3″	
		coal	1′ 6″	
		shale	1′ 0″	
		coal, good	1′ 6″	
4.	Concealed		10′	
5.	*Upper Freeport limestone*		12′	
6.	Concealed		75′	
7.	Sandstone, massive, visible (Freeport)		10′	
8.	Concealed		90′	
9.	*Coal blossom* (Kittanning Lower)		—	
10.	Shales, containing "kidney" I. O		10′	
11.	Concealed and sandy shales		50′	

Lower Coal Measures 264′

12. Sandstone, flaggy and massive		30′	
13. Massive sandstone, pebbly		60′	
14. Very pebbly bed		5′	
15. Massive sandstone, scattering pebbles		65′	
16. Shale, dark, containing fossil plants		10′	No. XII. 194′
17. *Coal, Quakertown?*	coal 10″ / shale 3″ / coal 5″	1′ 6″	
18. Fire clay		7′	
19. Black, fissile slate		15′	
20. Concealed		90′	
21. Shales, reddish		35′	
22. Sandstone, rather massive, greenish		35′	
23. Concealed, with occasional outcrop of green, flaggy sandstone to level of Cheat river at mouth of Bull run (960 A. T. Bar)		65′	

The structure of the Upper *Freeport coal* and *limestone* as given above, was obtained at a new opening on the road which crosses Bull run above Swindler's mill, and leads southward. The coal has been mined on the land of Mrs. Spurgeon in the immediate line of the section, but the opening had fallen in when I visited the locality, and the coal could not be seen. The coal is pitchy black with resinous lustre, is rather free from pyrite, and has every physical appearance of a good coking coal. The central bench just below the 3″ shale, is not so good as the rest of the bed, being somewhat slaty on the outcrop.

The Upper Freeport limestone is fully exposed in the ravine below the coal, and seems quite pure throughout, being light-gray, very compact, and breaking with a sharp clean fracture. It contains a minute, *univalve fossil.*

The basal portion only of the Freeport sandstone (No. 7) is visible; it is a coarse, grayish-white, micaceous sand rock, specked with ferric oxide, and very much resembles the same bed in western Pennsylvania.

The great sand-rocks of No. XII are completely exposed at this locality, and as will be seen from the section contain *no coal* until we come down to the *Quakertown horizon*, the *Homewood sandstone* having merged with the underlying beds, thus shutting out the *Mercer coal and shale series* at this locality, and giving us 160′ of rock in one solid mass.

The little coal bed, No. 17, is identical with that given in Sec. 2, at the mouth of Quarry run, and here, as there, is also double, and underlain by a large bed of *black slate.* The coal is quite pure, and contains much *mineral charcoal.* In the dark shales above it, were seen some fragments of *Cordaites* and *leaves of Lepidodendron.*

In the section at Quarry run, 35′ more of No. XII, principally massive grayish-white sandstones, occur below this coal, but here, on Bull run, everything is concealed at this horizon, and the character of the interven

ing rocks can only be conjectured. The topography would make them *shales*, and hence I think it probable that the sand rocks seen at Quarry run are absent here, and that the *black slate*, No. 19, rests immediately upon the *Mauch Chunk beds*, but should it prove otherwise, the base of No. XII would then be found about 30′ below the top of No. 20, thus making the entire thickness of this series 225′ instead of 194′, as given in the section.

The top of the *Mountain Limestone* must lie about 100′ below the level of Cheat river at this locality, where the centre of the syncline crosses.

At the mouth of Sandy creek, a massive, buffish-gray sandstone makes a bold cliff along the water's edge at 975′ A. T. (B), and 220′ below the base of No. XII.

As we pass up the river south-eastwards from the mouth of Sandy, the rocks begin to rise in that direction, and at one mile and a half above, the *Mountain Limestone* has completely emerged from the bed of the river, revealing the following structure along a steep ravine which puts into the west bank of Cheat (Sec. 11):

1.	Gray sandstone, somewhat massive	20′	
2.	Flaggy sandstone and sandy shales	150′	Mauch
3.	*Limestone*, impure	10′	220′
4.	Concealed and green sandy shales	30′	Chunk.
5.	*Red shale*	10′	
6.	*Limestone*, massive, gray	40′	
7.	Blue shale and impure limestone	4′	Mountain
8.	Shaly *limestone*	5′	Limestone
9.	Gray, calcareous shale	2′	94
10.	*Limestone* in massive beds, 1′–5′ thick	40′	
11.	Green shale	1′	
12.	Red shale	2′	
13.	*Silicous Limestone.* — sandy limestone	2′	8′
	blue limestone, rather pure	4′	
	silicious limestone, passing gradually into sandstone below	2′	
14.	Gray sandstone (Pocono) to level of Cheat	10′	

This section is valuable, because it gives the first complete exposure that we have had between the *Mountain Limestone* and the "*Silicious*" beds, showing them separated here by 3′ of red and green shales, and thus allying the "*Silicious limestone*" more closely with the Pocono SS. into which it passes by insensible gradations.

In continuing on up the river from this locality, the rocks still rise to the southeast, though not much faster than the bed of Cheat, since its fall is very rapid over this portion of its course.

In the vicinity of the "Great Falls," four miles above the mouth of Sandy creek, the west wall of the cañon, capped at top by the sandstone

of XII, becomes almost vertical, and give a very complete exposure of the rocks as shown in the following section (No. 12) obtained there :

1. Flaggy sandstone and concealed	25′	
2. Massive sandstone, top of *Homewood*	25′	No. XII, 220′
3. Concealed	90′	
4. Sandstone, very massive, pebbly	50′	
5. Sandstone, grayish white, somewhat flaggy	55′	
6. Green shales	15′	Mauch Chunk. 295′
7. Concealed, with blossom of *coal*	10′	
8. Green shales and sandstone	130′	
9. Sandstone, somewhat massive	25′	
10. Greenish, flaggy sandstones	135′	
11. Limestone and red shale	25′	Mountain Limestone 120′
12. Limestone	65′	
13. Limestone, interstratified with red shale	20′	
14. Red shale	10′	
15. "Silicious limestone"	35′	
16. Sandstone, massive, *Pocono*, to level of Cheat river, at Great Falls (1055′ A. T. Bar)	50′	

No. XII is here 220′ thick, or nearly 50′ greater than at Quarry run in Sec. 2, and it is possible that it should also include the 25′ of flaggy sandstone at the top of the section.

Small chunks of *coal* were seen mingled with other debris in the concealed interval, No. 7, and if they belong there, the bed would be in the *Mauch Chunk shale*, for No. 6, above, is unquestionably Subcarboniferous.

The "*Silicious limestone*" attains a thickness of 35′ at this locality, and even then it is doubtful, if I have carried it down far enough, since 10′–15′ more of the underlying *sandstone* possesses a very *limy* aspect in the great cliff which rises perpendicularly from the river at the Falls. The whole stratum is one solid mass from the top of No. 15 down to river level, the *Silicious limestone*, as well as the sandstone below exhibiting current bedding.

The "Falls" at this locality is a very rapid descent of the river for several rods over the massive portion of the *Pocono sandstone*, the stream descending about 10′ in as many rods.

The following section (13) was obtained about 300 yards above the Falls, in descending a timber chute where the logs in their rapid descent have removed the surface debris from several localities on the west bank of the river :

1. *Upper Freeport Coal*, reported	7′	
2. Concealed	200′	
4. Sandstone, massive, top of XII	50′	No. XII. 225′
5. Concealed	175′	
6. *Red shale*	10′	
7. Sandstone, flaggy greenish	40′	
8. Sandstone, coarse, buff	3′	
9. *Red shale with I. O. nodules*	10′	
10. Sandstone, green, flaggy, visible	50′	
11. Concealed to level of Cheat river	320′	

The Upper Freeport coal given in this section, has been opened along the road on the land of Mr. Graham, about one mile south-west from the top of the river bluff at No. 3, so that the interval of 200′ between the coal and No. XII, given by the barometer, should very probably be increased by 50′–75′, since the beds decline in that direction (S. W).

As we pass on south-eastward up Cheat river from the Falls, the rocks still continue rising gently for about two miles, when they turn over in the broad arch of Laurel Hill, and descend, carrying the limestones and shales of No. XI below river level, and finally submerging No. XII itself at Albright, in the centre of the trough, where the western bluff of the river reveals the following section (14) of the *Lower Coal measures:*

1.	Sandstone, somewhat massive, Mahoning?.....	30′
2.	Concealed.....	55′
3.	Shale, drab.....	15′
4.	Sandstone.....	2′
5.	Shale and fireclay.....	8′
6.	Shale, green, sandy.....	10′
7.	Sandstone, gray, massive, *Freeport*.....	30′
8.	Shale, drab.....	15′
9.	" dark blue.....	8′
10.	*Coal, Middle Kittanning* (*Darlington*).....	2′-3′
11.	Concealed.....	5′
12.	Limestone, nodular, (*Johnstown cement bed*).....	2′
13.	Concealed.....	23′
14.	Sandy shale.....	7′
15.	Sandstone, greenish.....	13′
16.	Shale, visible.....	5′
17.	Concealed to level of Cheat river at Albright bridge (1200′ A. T. Bar), and to top of No. XII, here in bed of river.....	25′
	Total height of section.....	255

From the thickness of the measures in the above section, it would seem that the *Upper Freeport coal* should be looked for immediately under the base of No. 1, which according to this identification would be the *Lower Mahoning sandstone*, but still it is possible that the *Lower coal measures* are here thicker than usual on Cheat river, and in that event the *Upper Freeport coal* would overshoot the top of this section.

No. 7 is undoubtedly the representative of the *Freeport sandstone* of Pennsylvania, while the coal, No. 10, would seem to be the *Middle Kittanning*, or *Darlington bed* of Western Pennsylvania, if Mr. Franklin Platt's identification of the latter with the coal overlying the *Johnstown cement bed* be correct; for the coal in question is here underlain by a grayish, nodular limestone that would well represent the "*cement bed.*"

The coal is quite good and has been gouged out of the hill to the depth

of a few feet for more than one-half mile in the vicinity of Albright's bridge, its rapid dip into the hill preventing systematic mining.

Just above the bridge, the *Homewood sandstone* rises from the bed of the river and makes a bold cliff along its north-eastern bank, revealing under it a small *coal bed* beneath a few feet of shales.

On above this to the south-east, the other members of No. XII. come up, and make the steep north-west slope of Briery mountain.

I shall close this paper with a single suggestion in regard to the parallelism of the beds along the Cheat river that I have included under the name *Mauch Chunk shale.*

A review of the sections will show that this interval, extending from the base of XII down to the top of the *Mountain Limestone,* has a thickness of about 300′, and can be subdivided into three well marked groups: 1st, at top, a *shale interval* often containing *iron ore* and one or more thin *red beds,* thickness 30′—50′; 2d, a series of flaggy, green sandstones, often having a quite massive bed near the top, and sometimes containing *calcareous bands* 1′–2′ thick, thickness 165′; 3d, a series of red and green shales in which usually occur one or more thin beds of impure limestone, thickness down to the main mass of *Mountain Limestone,* 80′–100′.

Those who have read my summary of the Geology of Crawford and Erie counties, Pa., in Report Q[4], will recall that I there show the "Cuyahoga shale," of Dr. Newberry to be a very composite series, having a structure somewhat as follows, beginning with the base of XII, and descending to the *Berea Grit* (Corry sandstone):

Shenango shales	35′–50′
Shenango sandstone	25′
Meadville Upper shales	20′
" " Limestone	1′
" Lower shales	45′–55′
Sharpsville Upper sandstone	50′
Meadville Lower limestone	2′
Sharpsville Lower sandstone	12′
Orangeville shales	75′
Berea Grit	—
Total average thickness about	280′

The above succession, I have traced southward from Crawford county to the mouth of the Beaver river at the Ohio, more than half way to Cheat river, and in oil borings at Beaver falls, Smith's ferry and other localities, the series is still 270′–280′ thick.

As is well known, the geologists of the 2d Geological Survey of Pennsylvania, who have studied the *Sub-conglomerate measures* in the western counties, have all heretofore placed the dividing line between XI and X, in the *Shenango shales,* and regarded the massive sandstone below them as the beginning of the *Pocono.*

It will be seen at a glance that the "Mauch Chunk shale," interval on

Cheat river has a striking stratigraphical resemblance to the "Cuyahoga series" in Western Pennsylvania, a shale interval at top and bottom with an intervening sandstone interval—Shenango—Sharpsville Lower—of practically the same thickness in each case. The query here suggested is, can the "*Mauch Chunk shale*" interval, 300′ thick on Cheat river in Monongalia and Preston counties, be identical with the "*Cuyahoga shale*" series as given above from the Ohio line counties in Pennsylvania? The answer is yet quite doubtful, but the only evidence obtained at present, seems to point to an affirmative reply.

Stratigraphy gives an answer decidedly in the affirmative, for the succession in each case is practically the same, and yet we must not forget that the nearest points to which the series have been traced—mouths of Beaver and Cheat rivers—are separated by some 60 miles, in which these beds are buried from sight by the overlying Coal Measures. It should be stated, however, that the lithology of the 165′ sandstone series on Cheat river is often strikingly like that of the *Sharpsville beds* in Pennsylvania, and also that it sometimes contains, near its top, a massive brown sandstone that would correlate well with the *Shenango SS.*

But what say the *fossils* to this supposed parallelism?

On Cheat the "*Mauch Chunk beds*" are not fossiliferous, so that we cannot compare them directly in this respect.

The "*Cuyahoga*" *beds* are often quite fossiliferous, however, and the evidence that they furnish is curious, as showing an apparent contradiction in the answer to our query given by two classes of organisms—*Mollusks* and *Fishes.*

The *Meadville limestones* in the "*Cuyahoga*" *beds* are, in Crawford county, filled with *remains of fishes, scales, bones, teeth, dermal structures,* &c., and in the Spring of 1880 I sent some of these fossils to Prof. Worthen, the eminent Palichthyologist of Illinois, for his opinion as to their geological horizon. He replied that they seemed to him to belong unquestionably with the *fish beds* of the *Chester limestone* at the west, and I should add that this remark of Prof. Worthen first suggested to me the possibility of an identity between the "*Mauch Chunk shales*" of Cheat river, and the "*Cuyahoga*" *series.*

The *Molluscan remains* found in the "*Cuyahoga*" *series,* however, seem to ally them more closely with the *Waverly sandstones* (Pocono), which underlie the shales and limestones of No. XI, and in my Report on Crawford and Erie preference was given to their side of the story. It now seems possible, as suggested above, that the testimony of the *Fishes* may yet have to be received in preference to that of their more lowly cousins, the *mollusks,* and the "*Cuyahoga shales*" of Newberry, relegated to the horizon of No. XI, where they were long ago placed by Prof. Lesley on general stratigraphical grounds (see his scheme of Ohio and Pennsylvania formations correlated in Report I, 2nd Geo'l Sur. Pa.).

The apparent contradiction in the evidence given by the two classes of

organisms may be satisfactorily explained, when it is remembered that the open sea in which the great Mountain Limestone of Cheat river—the Chester, St. Louis, and other beds of the West—accumulated, shoaled away to a beach line of muddy shallows in Eastern Ohio and Western Pennsylvania, similar in every respect to the *Waverly* and *Pocono* beaches that had preceded them, and consequently we should expect to find the life forms that had inhabited the latter, continuing on with but slight changes up into the edges of the Mauch Chunk series, where, overlapping the *Mountain Limestone*, it practically continued the Pocono beaches on to the close of the Subcarboniferous epoch.

Stated Meeting, November 3, 1882.

Present, 12 members.

Vice-President, Dr. LE CONTE, in the Chair.

Letters accepting membership were received from C. Rau, dated Smithsonian Institution, Washington, Oct. 25, and from Garrick Mallery, Bureau of Ethnology, Smithsonian Institution, Oct. 28.

Letters of acknowledgment were received from Thomas C. Porter, Easton (111); and the Smithsonian Institution, Washington (110,111).

A circular letter was received from the Department of the Interior, dated Oct. 26.

Donations for the Library were received from the Zoölogischer Anzeiger, Leipsig; Academy at Brussels; Geographical Society, Paris; London Nature; Canadian Naturalist, Montreal; American Academy of Arts and Sciences; American Journal, New Haven; N. Y. Meteorological Observatory at Central Park; Franklin Institute, Philada.; Hon. Thomas H. Dudley, Camden; Signal Service Bureau and U. S. Engineer Department, Washington; and the Chapultepec Observatory, Mexico.

An obituary notice of Ralph Waldo Emerson was read by Rev. C. G. Ames.

The death of C. G. N. David, Ph.D., was announced from the Royal Danish Academy, Copenhagen. [No date or age given.]

The death of Mr. B. V. Marsh, at Burlington, on Oct. 30, aged 62, was announced.

The Committee on Com. McCauley's Memoir, reported progress.

The Committee on Dr. Wood's Memoir, reported progress.

Mr. Lesley exhibited some of the recent publications of the Second Geological Survey of Pennsylvania, and showed how near completion it now is.

The Minute, written by the President, at the request of the Society, at its last meeting, was read.

In accordance with the resolution adopted at the last meeting, the President presented the following for entry on the Minutes:—

The two hundredth anniversary of the founding of Pennsylvania was celebrated during the week ending October 28th, 1882.

The exercises and exhibitions were of a character to recall the scenes of the arrival of the Founder, his dealings with the aboriginal inhabitants, his offers to first settlers, and the enactment of his great laws for securing liberty of conscience, equality of civil rights, and the regular and impartial administration of justice.

To these were added civic displays showing the ancient and present forms of civilization that had existed and now mark the condition of our noble Commonwealth, and illustrate its present state of population, wealth, diversity of employments, manufactures, general resources, and the numerous forms in which society is divided for the promotion of benevolence, temperance, charity, and social enjoyment.

The closing displays were of the military organizations in which the defenders of the Union in the late civil war participated in large numbers and by the union of those representatives of the past with the representatives of the present in organizations for the defence of the country, for the protection of the people and for the general welfare of the republic, was seen the admirable working of our American systems of military provisions.

The celebration was a great jubilee participated in by immense numbers of the citizens of Pennsylvania and cordial sympatizing visitors from other States, and it will distinctly and vividly mark a great epoch in our history.

From the handful of settlers that landed with Penn, the population of

the State has swelled to four millions and one-half of people, and that of the City of Philadelphia to one million.

Of all the history of State and City we may be justly proud, for the foundations on which it was built have been preserved and strengthened.

Of this vast growth our Society has been the living witness, for it was founded only sixty years after the landing of William Penn; and it is fitting that in addition to the full accounts that will be given by chroniclers of this great event and which will form part of our library, this brief notice of it should constitute part of our Minutes.

Pending nomination No. 969 and new nominations Nos. 970 to 976 were read.

And the meeting was adjourned.

Obituary Notice of Ralph Waldo Emerson. By Charles G. Ames.

(Read before the American Philosophical Society, Nov. 3, 1882.)

Ralph Waldo Emerson, whose name has honored the records of this Society since 1868, was born in Boston, May 25, 1803, and died in Concord, Mass., April 28, 1882. Of mixed Puritan and Huguenot ancestry, he brought into the 19th century the essences rather than the forms of Calvinistic creed and culture; and grew up as the handsome flower of a sturdy stock. His being was like a retort into which many generations of thoughtful piety had been distilled; for never was a clearer case of hereditary marking than in his tendency to the independent pursuit of high and sober studies. He had the physical make-up of a student, with just enough of healthy muscular development to furnish sheathing for a nervous structure of extraordinary fineness and vigor.

Of how many New England lads, in the early part of this century, may the same story be told: Graduating from Harvard at 18, then teaching for a while, then settling to the study of divinity. Already familiar with Plato and Montaigne, whose mixed coloring matter had passed into his blood, the lad was yet fond of Augustine, Pascal, and Jeremy Taylor. He had also come in contact with the free devoutness and benevolence of Dr. Channing, and had yielded to the spell of Wordsworth and Coleridge. A little later he was to feel the powerful influence of Carlyle and Goethe.

In 1826 he began to preach; in 1829 he was ordained and installed minister of a Unitarian Church in Boston. His sermons struck the dominant note of all his later thinking and writing, their evident purpose being to induce in each hearer the assurance of "life in himself." It was this intensity of faith in the intimate relations of each human spirit to the Di-

vine, along with a clear perception of religious symbolism in all facts, that made traditional outward observances at first a matter of indifference, and then of oppressive unreality. In three years and a half, his pastoral relations were amicably dissolved, because he had reached conclusions essentially like those of the Society of Friends concerning the valuelessness of the ordinances.

The strain of these experiences was severe; but the liberty which now came to him was utilized to the advantage of mind and body by a voyage to Europe, which brought him to personal acquaintance with the eminent men whose genius had already lighted his way. On his return he established himself for life in the quiet rural village of Concord, and entered on a ministry for which no pulpit then seemed large or free enough—a ministry which, running through forty-eight years, to his death, gradually found through press and lecture platform its own fit audience; small at first, but, as the event has proved, sufficient to put him in vital connection with the mind of the world.

Carlyle, whose wine had not yet turned to vinegar, was then putting forth his testimony in England, with a limited hearing. He, as well as the American public, was indebted to Emerson for the reproduction of "Sartor Resartus" and a volume of "Critical and Miscellaneous Essays" on this side the water. Coleridge and Carlyle had inoculated the English mind with the nobler German literature; Emerson was one of those through whom it passed to America; and to many an ingenuous youth it was like the discovery of new worlds.

But no imported mental fertilizer has proved more effective than the native product. Emerson himself has probably influenced our ways of thought and feeling and expression quite as much as any man of the century; and all this without the arts or qualities of popularity, and even in spite of multitudinous protests. The semi-mystic quality of his thought predisposed him to sympathize with the subtle spirituality of Plato and the great Germans; and the New England mind, weary of the old mechanical theories of creation and revelation, was ripe for revolution. Transcendentalism, which is a wholesale believing, came in good time to save us from wholesale denials. Mr. Geo. W. Cooke describes this movement as "an attempt of the human mind to recover a natural and assured faith in moral things." This faith finds due warrant in our direct original perception of spiritual realities, by a power which transcends the senses—a power which is proper to all men, and which is our share in that universal and absolute Reason out of which flows the whole order of the universe.

The practical applications of such a philosophy are endless. Creation being an expression of the Infinite Intelligence, poetry finds its divine justification and rises into a hymn. Nature appears as a mirror of mind, and all her laws and secrets correspond to our clearest inward discoveries, so that science becomes a parable. And as reason is one thing in all men,

all men become ministers to each other's completeness. What Emerson has to say of Personal Conduct and Social Aims comes to this: That, as it takes all sorts of men to make a world, each one of us can best contribute to the perfect result by giving full scope to all that properly belongs to himself. Be a brick and there will be a place for you in the wall. Every man, like every grain of sand, is a theatre for the play of all the powers and laws of the Kosmos. To distrust yourself is atheism; to despise your neighbor is blasphemy; to help yourself to all the benefits the universe offers—through nature, books, society, solitude, industry and repose—is only to come into your inheritance, and is therefore the true method of culture. Disorder, misery, chaos, perdition—they all come from inward defect and non-fidelity.

All this, and the system of thought to which it belongs, may seem tame and trite enough now, but it sounded strange and heretical a half century ago. It was indeed a republication of the best thought of earlier ages; but it was foreign to the common literature and the current religion.

In 1837, Emerson gave his address on "The American Scholar," before the Phi Beta Kappa Society of Harvard. Mr. Alcott tells us that it was heard with delight by some, but with confusion and consternation by others; or, as James Russell Lowell says, with "enthusiasm of approval and grim silence of foregone dissent." Yet it does not now strike us as dangerous doctrine to teach that America ought not to depend on imported ideas but should produce her own scholars, and that these should seek truth and reality from original sources. We are no longer scared if a bold thinker declares that truth should spring out of the earth, whereon *we* tread, and that righteousness should look down from the heavens that bend over *our* heads, as well as from the soil and skies of ancient Palestine. Nor is it any longer an unsavory and *outré* discourse which teaches that character is the end and aim of all truth and all discipline. It is almost startling to consider how lightly and cheaply, and as matters of course, we hold certain grand truths which make our common daylight, but which to former times were like unrisen stars. A knowledge of the inward world has grown with a knowledge of the outward world.

> "Few mortal feet these loftier heights had gained
> Whence the wide realms of Nature we descry;
> In vain their eyes our longing fathers strained,
> To scan with wondering gaze the summits high
> That far beneath their children's footpaths lie."

It is not important to determine Emerson's relation to metaphysical systems. He was neither ignorant of them nor fond of them, being very shy of finalities. But in his attempt at simple and large statement, he seems to have incorporated the best results of other men's thinking.

There are passages in Mr. Emerson's writings which strongly arraign what he once called "this mountainous folly of Church and State;" but this is only his fine scorn of sham and make-believe. He is never vio-

lent against institutions; he honors their real merits and services; but he trusts wholly to vital energies for improvements and reconstructions.

The total effect of his work has been to disclose our undeveloped resources, to make us aware that we are born to an inheritance of infinite richness, and that no man need hesitate to avail himself of all the advantages which the universe offers. At the same time, his writings operate as a continual rebuke of self-consciousness, cowardice, cupidity, weak indulgence and pretence. To read Emerson *sympathetically* is to be enlarged, liberated, shamed out of mean, self-regard, and lifted into universal fellowships.

Not the least notable trait is a certain comprehensiveness, nurtured by his philosophy. His writings abound in allusions which show his mental omnivorousness, his quick sympathy with the thought of all ages and times, his hospitality to "many men of many minds," his ability to grasp and reconcile contrarieties, and the ease with which he found a place for all sorts of facts. Revelling in the abstruse, and living much on the mountain-top where he could catch and report downward to mortals the wandering whispers of the upper air, he yet joined with Bacon in honoring "the studies that are for delight, for ornament, and for ability," and held in high appreciation the men of affairs and the masters of action.

A tone of playfulness testifies to the health of his spirit. There is no trace of moodiness or indigestion in his writings, no sour eructations, no narcotized imaginings, no sore-headedness nor skin-blotches, nor any sign of the itch for praise. He makes it easier to believe in miracles of healing: virtue goes out of him for the driving away of sad and surly humors and the rectifying of small insanities.

The material of his poetry is too much like that of his prose to address a different class of minds. The ideas of his essays set themselves to music and mount on wings. Nature supplies imagery and vehicle; for in nature, as in God, he lived and moved and had his being. There is a subtle, never-dying charm in this clear-obscure where earth and heaven meet. The verse, whose theme flames up toward the infinite, yet smells of the soil and the breath of kine; it smacks of tree-sap and sea-salt; the country-brook glides into the lines; one hears the wind-harp and the bird-song; the "dedicated blocks" of granite build the mountain into an altar from whose top the cloud-rack flows like incense. And nothing goes on in leaf or shell, in chemic eddies or solemn march of constellations, in the little life of the insect or the grand sweeps of history, but lo! these are parts of the ways of the all-perfect Over-Soul—the mystery ever disclosed yet ever hidden.

Many random readers receive the impression that there is nothing like unity or method in Emerson's mind; that his works are but a heap of brilliant, unrelated fragments. True, he lacks literary unity, and is careless of logical construction; and he despises the charge of inconsistency as "the bugbear of little minds." But once grasp his larger meanings,

or look from his central point of view, and his thought appears as whole as the globe or the solar system. It would not be easy to find a leading author whose mental products are more coherent or who is so free from self-contradictions. He is indeed at no more pains to protect himself from the *imputation* of contradiction than is a photographer who shifts his camera to secure a dozen views of the same landscape. If the pictures tell different stories, that is no affair of his: let nature look to it!

Emerson is said to have pleased himself with the "hope of a world in which we shall see things but once, and then pass on to something new." I construe this extravaganza, not as the sign of a mad love of novelty, but as a rebuke to mental inhospitality, as the expression of his strong faith that all facts and truths must agree, and that the universe can supply inexhaustible variety without danger of falling back into chaos.

With all his high soarings, he was at home on the ground, and astonished his friends by his practicalness and aptness for business. His occasional deliverances on public affairs were clear and weighty. One who sat with him on the Board of Overseers of Harvard University, says that his judgment was as much "waited for" as that of any other member. Another testifies that his discretion in regard to investments in stocks, etc., was quite equal to his ability as a writer and thinker.

It would indeed be possible to gather out of his ten volumes an excellent body of maxims for every day use, shrewd, pithy, and full of mother-wit. But his claim to our grateful respect rests on far higher grounds. He was not merely virtuous; he was virtue itself; and he taught to all men its open secret. And he has illustrated in life-size, the close-blending of high intelligence with high excellence. In his writings and in himself, the ethical quality is inseparable from thought. He never puts it on, he never puts it off—a sore puzzle to those who judge of possession by profession, or who think of the Holy Ghost as an occasional visitor, and not as a permanent resident in the human temple.

One who knew him long ago and later, says he gave the impression of a humble listener and learner. This tells the whole story of his greatness. For such an attitude implies neither empty narrowness nor idle passivity. To be, as he was, in sympathetic relations with the thoughts of mankind in all ages, and yet to lie open, as he did, to the teachings of primal reality—passionless, unprepossessed and unprejudiced—requires not only fine susceptibility, but a mind of great breadth and power. But his activity is easy and unconscious to himself; his faculties play like the strings of an æolian harp, because they are played on by invisible power. One result appears in the impersonal quality of this work. He never attacks and never defends. He searches defects and exposes error as the light does. He criticises, not by analysis, but by insight; like his own humble-bee, he simply leaves the chaff and takes the wheat. This mental process implies great labor-saving. What need to handle over and over the

crude mass of facts and phenomena, when one can directly seize their essence and meaning, as the evening wind seizes the fragrance of a whole meadow full of flowers, without disturbing root, stalk or petal?

I believe the first appearance of Mr. Emerson's name in the Proceedings of this Society, since his election to membership, is in the announcement of his death. But he was one of the few Americans who have deservedly gained the name of a philosopher, in both its original and its acquired sense. A lover of wisdom, he also searches with keen insight behind phenomena into the mystery of causation and the unity of law; and he converts all knowledge into value by showing its uses in the production and perfecting of the ideal life. "To live with the gods" and "to keep the divinity within us free from harm," was the lofty aspiration of ancient wisdom; and "the science of living" has not yet advanced beyond these maxims of the Stoics, which seem identical in purpose with the Hebrew and Christian ideal of a pure heart and a life fashioned in the image of the Highest. Though our great good friend has not wrought as an organizer of knowledge, he has accomplished the larger work of profoundly stimulating the human mind and turning it to noble pursuits; and he has illuminated the whole field of research. Structure in his view was always inferior to function, and function to purpose or spirit. As an interviewer of nature and of the soul, his office was to report—to interpret the universe to man, and man to himself. In all this there are no finalities; since, as J. S. Mill remarks, "On all great subjects there is always something more to be said." But many a coming seer will find a fountain of light for cleansing his eyes from earth-dust in the rays that stream from the mind of Ralph Waldo Emerson.

Stated Meeting, Nov. 17, 1882.

Present, 9 members.

Vice-President, Mr. PRICE, in the Chair.

Letters of acknowledgment were received from the Royal Society, Upsal (xv., 3; 104–108); Swiss Society of Natural Science (107, 108); Society of Physics and Natural History, Geneva (xv., 3; 106–108; List of Members); Royal Society of London (xv., 3; 107–109); and Cincinnati Observatory (65–80, 88, 92, 107, 110).

Letters of Envoy were received from the Royal Academy of Stockholm; Royal Society of Upsal, dated June 15, 1882;

Hungarian Academy, Buda Pest; Imperial Academy, Vienna, July 16, 1882; Royal Prussian Academy, Berlin, June, 1882; Society of Natural Science, Marburg, April, 1882; Swiss Natural Science Society; Royal National Library in Florence, March 24, 1880; Holland Society, Harlem, June 3, 1882; Fondation Teyler, Harlem; Meteorological Office, London, October, 1882; and Royal Observatory, Greenwich, November, 1882.

Donations for the Library were received from the Academies at Stockholm, Buda Pest, Vienna, Berlin, Modena and Dublin; the Observatories at St. Petersburg, Stockholm and Greenwich; Royal Society, Upsal; Société Hollandaise, and the Musée Teyler, Harlem; Royal Geographical Society, Royal Geological Committee and Anthropological Society, Vienna; German Geological Society, Berlin; Prof. G. D. E. Weyer, Kiel; the Societies at Bremen, Marburg, Leipsig, Görlitz, Freiburg i B., Lansanne and Geneva; Swiss Natural Science Society; Royal Venetian Institute; Royal National Library, Florence; M. Georges Edon, Paris; Royal Society, and Meteorological, Geographical, Geological, Linnean, Zoological, and Royal Asiatic Societies, London; Meteorological Committee, and Nature, London; American Academy of Arts and Sciences; Boston Natural History Society; American Journal of Pharmacy; Dr. D. G. Brinton, and Dr. E. W. Syle, Philadelphia; American Journal of Mathematics, Baltimore; and the National Museum of Mexico.

A letter was received from the Colonial Museum of New Zealand stating that they had received nothing from this Society since 1871.

The death of C. Arfwedson, of Sweden, was announced.

The Committee to whom was referred the Egyptian Vocabulary of Commodore McCauley reported in favor of its publication in the Transactions. The subject was referred to the Publication Committee.

The Committee to whom was referred the "Researches on Diphtheria" by Drs. Wood and Formad, reported in favor of

its publication in the Transactions. The subject was referred to the Publication Committee.

The minutes of the last meeting of the Board of Officers and Council were read.

Pending nominations Nos. 969 to 976 were read and the meeting was adjourned.

Stated Meeting, Dec. 1, 1882.

Present, 11 members.

President, Mr. FRALEY, in the Chair.

A letter accepting membership was received from Prof. Hermann Kopp, dated Heidelberg, Nov. 7, 1882.

A letter of envoy was received from the Museum of Comparative Zoölogy, Cambridge, Mass.

A letter of acknowledgment (XIV, 2; 62, 97), and envoy was received from the Société de Géographie, dated 184 Boulevard, St. Germain, Paris, Nov. 13, 1882.

A letter requesting exchange of publications was received from the U. S. Naval Institute, Annapolis, Md., Nov. 21, 1882. On motion, it was resolved that the U. S. N. Institute be placed on the list of corresponding societies to receive the Proceedings.

Donations for the Library were received from the Department of Mining, Melbourne; Royal Museum of Natural History, Bruxelles; Revista Euskara; London Nature; Canadian Naturalist; Museum of Comparative Zoölogy; Meteorological Observatory of New York; Franklin Institute; Prof. E. D. Cope; American Chemical Journal; U. S. Naval Institute; U. S. National Museum and the Light House Board, Washington.

The death of Prof. Henry Draper at New York, November 20, aged 45, was announced. On motion, Professor Barker

was requested to prepare a minute of Professor Draper's death for the Proceedings of the Society.

Mr. Lesley made some remarks on the Egyptian character of certain Hebrew names:

Mr. Lesley first described the history of the *user*, or Jackal-headed staff, representing victory, from it first appearance in the 4th to its habitual use in the 12th and 19th dynasties, in royal names; especially remarking on the form *User-n-ra* of the 5th dynasty. This name corresponds to the Hebrew name *Israel*, spelled ISR·AL, which an Egyptian would express by the hieroglyphic USR·RA. The origin of the personal name is given in the well known Scripture legend of Jacob wrestling with and prevailing over a mysterious visitor, in the night preceding his momentous interview with his brother Esau. This name, *Esau* (עשו, ôsu), Mr. Lesley identified with the Edomite *Shasu*, who successfully invaded Egypt at the beginning of the 19th dynasty, but were the principal foreign enemies of Egypt on the east for some centuries earlier.

The Publication Committee reported that they had resolved that Commodore McCaulay's Egyptian Vocabulary be placed in the hands of the lithographer, to be printed as soon as practicable.

The annual report of the Treasurer was read.

Mr. Phillips, for the Special Committee appointed to examine the documents belonging to the Society, reported the following results of the investigations of that Committee:

1st. An Ordinance of Gov. John Evans creating Court of Equity, and giving certain powers to Courts of Common Pleas to hold special Courts to aid persons about to leave Commonwealth, of date Feb. 22, 1706.

No. 2. Letter of Attorney by William Penn, appointing Thos. Loyd his attorney, and memorandum in Penn's handwriting on back, dated June 6, 1684.

No. 3. Assignment of Mortgage, by Thomas and Richard Penn, dated Oct. 2, 1765.

No. 4. Charter of Chester signed by William Penn, dated Oct. 31, 1701.

No. 5. Charter of Privileges by Wm. Penn to Penna. 31st, 8 mo. 1701.

It is recommended by your Committee that the above valuable original papers be placed in the vaults of the Fidelity Insurance Company, with other property there, to be endorsed "Original Penn Papers."

No. 6. Printed report of order of business as settled by order of 1841. It is recommended that all except two copies be destroyed, the others preserved by the Librarian.

No. 7. Geological treatise in German with plates. It is recommended that they be bound and placed in Library.

No. 8. Distribution Book of Proceedings of American Philosophical Society. Recommended to be placed in Library.

No. 9. Communication from Mr. Duponceau with regard to History of the Society of 1841. Recommended that they be bound and placed in Library.

No. 10. Map of New Sweden. To be mounted.

No. 11. Plan for unknown of buildings. To be placed in Library.

No. 12. Duponceau manuscripts on international law. To be bound and placed in Library.

No. 13. Deed by John Fitch, Feb. 9, 1787, and others creating Steamboat Company. To be placed in vaults.

No. 14. 1769 Commission of Thomas Penn. Richard Penn to Edward Physick, appointing him Keeper of Great Seal. To be placed in vaults.

No. 15. Manuscripts relating to the Centennial of Society in 1841, also certain communications, &c. If these have not been printed to be bound.

No. 16. Subscription book to relieve the Society from Indebtedness of date of Jan., 1846. It is recommended to be placed in archives of Society.

No. 17. *a.* Two bank books of 1831 and 1849.
b. Lists of 1826, 1831, 1842 and 1846.
c. Four minutes of committees to be consolidated.
d. Stub of check book.
e. An account of Treasurer, old receipts of books from Library.
f. Lot of old account books.
It is recommended that the above be boxed up and placed in the Library.

No. 18. Package of letters of Peter Collinson to various persons.
These, if possible, to be repaired and bound, and for the present to be in the Safe Deposit.

No. 19. Copy of Definite treaty between Great Britain and United States, A. D. 1783. To be bound.

No. 20. Copy of proclamation giving prices for scalps. To be mounted.

No. 21. Letters to and from Benjamin Franklin. To be bound and indexed.

No. 22. Lot of old Diplomas not delivered. To be sent to lineal descendants if found.

No. 23. Lot of receipts taken by Franklin in France for advances. To be bound.

No. 24. Invitation to Dr. Franklin to attend a Masonic Lodge des Neuf Soeurs supper, signed by De Gebelin. To be bound.

PROC. AMER. PHILOS. SOC. XX. 112. 3L. PRINTED JANUARY 22, 1883

No. 25. Printed invitations and notices to Benjamin Franklin when in France. To be bound.

No. 26. Correspondence of Benj. Franklin. To be bound.

No. 27. Various old shop cards to be mounted in scrap book.

No. 28. Sundry printed papers relating to Revolution. To be bound.

No. 29. Letter of Benj. Franklin with regard to non-importation agreement of 1770 to Humphrey Marshall. To be placed with Franklin papers.

No. 30. Letters with regard to pictures of Franklin.

No. 31. Old Catalogue of Donations. To be preserved.

No. 32. Certificates of membership in Sons of St. George of John Vaughn. To be given to relatives.

No. 33. Certain Bank notes of John Law's Bank to be placed in a scrap book.

No. 34. Certain memorandums of Heckwelder with regard to Indians. To be preserved.

No. 35. Accounts of prices with regard to building of Hall of Society. To be bound if possible.

No. 36. Accounts with regard to Society. To be bound.

No. 37. Letters and Accounts with regard to Society. To be bound.

No. 38. Communications from Lymes with regard to the hollowness of the earth. To be bound.

No. 39. A variety of old vouchers, manuscript catalogue and Treasurer's Accounts. To be boxed up.

On motion, the recommendations of the Committee were adopted, and the Committee empowered to carry their recommendations into effect.

After an informal interchange of views respecting the practicability of proceeding with the printing of the last part of the Catalogue, and of commencing the printing of the early records of the Society, the meeting was adjourned.

Stated Meeting, December 15, 1882.

Present, 9 members.

Dr. BRINTON in the Chair.

Letters accepting membership were received from G. Tschermak, Director of the Mineralogical Institute, dated XI Maximilian platz 15, Vienna; and from F. Reinhard Blum, dated Heidelberg, Nov. 20, 1882.

Donations for the Library were received from the Trustees of the Indian Museum at Calcutta; the Royal Academies at Munich and Brussels; the Zoologischer Anzeiger; the Batavian Society; the Royal Library at the Hague; the Royal Museum at Brussels; Dr. L. G. DeKoninck, of Liége; the Geographical Societies at Paris and Bordeaux; the Revue Politique; the Royal Astronomical Society, Lords Commissioners of the Admiralty, and Nature, London; Harvard College Observatory; American Journal of Science; Mr. Henry Whitall, Philadelphia; the U. S. Signal Service Bureau, and Fish Commission, and a copy of Lieut.-Com. Gorringe's illustrated book on the Obelisk, from Dr. Persifor Frazer, Philadelphia.

Dr. Frazer read a communication on "The horizon of the South Valley Hill Rocks in Pennsylvania."

Prof. Cope communicated a paper "On the Brains of the Eocene Mammalia: *Theocodus* and *Pteryptichus*," with two octavo plates.

Pending nominations 969 to 976, and new nominations 977 to 980, were read.

And the meeting was adjourned.

The Horizon of the South Valley Hill Rocks in Pennsylvania. By Dr. Persifor Frazer.

(*Read before the American Philosophical Society, December 15, 1882.*)

The regions of the State in which the above rocks occur having been independently studied by different observers, their labors have been brought to contact, and it is found that a difference of theory almost as old as geological investigation in this country, exists in the respective views of the workers.

The substance of one of these theories has just been issued in the Report C_6, of the Second Geological Survey Reports, of which the subject is, "Philadelphia County and the southern parts of Montgomery and Bucks, by Mr. Charles E. Hall." *

The first argument advanced to prove the formation of the schists of the South Valley Hill subsequently to the Chester limestone is, that all the dips of the latter are southward or under the former. That this is so in the majority of cases (though with dips differing both in direction and intensity), is undoubtedly true, but there are exceptions to this rule in Sadsbury, Caln, East Caln, West Whiteland, East Whiteland and Treddyfrin; in other words, in six out of the seven townships in which this contact occurs in Chester county. [See table on page 108 of Memoir on the Geology of S. E. Pennsylvania, by writer.]

These exceptions to the general rule are just of such a character as one would expect if a fault had traversed a region of high but generally reversed dips. †

* In the introduction to this volume, Prof. Lesley mentions the Serpentine of Bryn Mawr as turning south towards the town of Chester, and not continuing in its south-west course through Delaware and Chester counties. The evidence of this did not appear from a somewhat rapid search through Mr. Hall's volume. On page 88 he gives the course of the Serpentine as far west as to a point a little south of Bryn Mawr, and on pp. 25 and 26 he speaks of the outcrops as belonging to one deposit, and clearly indicates his belief that they are of synclinal structure though apparently scattered.

It is difficult to believe that the Serpentine at Bryn Mawr is not connected with that north of Radnor, &c., and does not belong to the belt which traversing Chester county with a breadth between the extreme lines of isolated outcrops of from five to eight miles, becomes very largely developed in West Nottingham and the neighboring townships of Chester and Lancaster.

† It is of course a slip of the pen when Prof. Lesley says that the presence of Hudson River plant-forms is shown in Prof. Frazer's Report C_2. C_2 is devoted to Adams and part of Franklin counties, &c. Nor is any such statement in C_3.

There was in the collection of specimens at the Lincoln University a fossil said to have been found in one of the Peach Bottom slate quarries which was determined to be *Buthotrephis flexuosa*. All efforts, however, to find this fossil in place were unsuccessful. Besides this, even if the Peach Bottom slates were determined to be of Hudson River age, it would be very far from proving that the great mass of the South Valley Hill schists was of this age. Pains were taken in the description of the Susquehanna Section, pp. 140-141, to show that the structure below Fishing creek, and especially near Peter's creek, was not by

The writer takes issue with Mr. Hall, as will appear further on in his statement, as to the absence of large masses of schist in contact with the Potsdam and with the Laurentian north of the Chester valley.*

Mr. Hall's argument is virtually as follows :

(1.) "*The Philadelphia, Manayunk and Chestnut Hill beds or the South Valley Hill, which is equivalent to part of them, cannot be lower than the Laurentian* (*Third Belt of Rogers*)."

This will be universally conceded.

(2.) "*It is clear that the Potsdam sandstone was deposited on this Third Belt.*"

This is not clear except, perhaps over a limited area. It is not true of the Potsdam in Lancaster, nor is it true of the Potsdam in Southern Chester, nor in parts of Northern Chester. For instance, the evidence that the Potsdam, between Doe Run and Toughkenamon, underlies the limestone and overlies the chlorite schists of that region is very strong. If the limestone interposed between the quartzite and the schists, then a border of limestone should show on the east and west ends along the irregular boundary of the Potsdam area, but it does not.

A series of small detached exposures of limestone stretch east by north from the Doe Run limestone and like the latter show no trace of Potsdam on their northern edges. These as well as the Doe Run limestone, are held to be older than the Potsdam, because the dip is S. or S. E. continuously from the South Valley Hill southwards, *decreasing* in intensity in that direction, so that if not monoclinal the structure must be considered *anticlinal*, and *cannot be synclinal*. The meaning of this is that the Doe Run limestone is younger than the crest of the Valley Hill, and that its southern edge is younger than its northern edge (since the preponderance

any means as clear as in the region north-west. It would be perfectly easy, as there pointed out, to place the Peach Bottom slates *above the quartzite* without deranging the structure of the upper region, as therein suggested. The objection to placing the series above the limestone, *i.e.*, that no limestone appeared between the gentle axis of Tocquan creek and the slates, of course would not be an objection to those who credit the Tocquan schists themselves with being above the limestone.

Two explanations of Hudson River slates at Peach Bottom are possible without changing the horizons of the measures to the N. W. One is the omission here altogether of the limestone in the series. The other (held by Prof. Barrois, who visited the region), a fault line north of the slate belt.

It is only fair to admit, however, that the Hudson River age of these quarries is not proven.

*The discovery of Mr. Lewis as to the two kinds of scratches made by the ice and the creep, must be regarded as an important application of the reasoning of the Scotch geologists to our own country. In some cases Mr. Peach and Mr. Horne have been able to distinctly ascribe three distinct lines of markings to movements of very different age.

The colors on the geological maps are somewhat confusing. The dark red, which in the scale is called the intermediate Manayunk belt, seems to be applied on the map to the northerly Chestnut Hill group, and *vice versa*.

of southerly dips continues across the belt). On its southern edge rests the Potsdam in W. Marlboro' township, still with a south dip (*i.e.*, S. 10° E.–45°; S. 5° E.–70°; S. 20° W.–40°; E.20° S.–40°, &c., &c.), that rapidly becomes gently undulating and almost horizontal: and this structure continues to the Delaware line.

The axes of the Chikis anticlinal folds can be seen to be mica schist of similar character to that of the South Valley Hill.

The rock underlying the possible Potsdam quartzites in the lower Susquehanna, are clearly of the same character and series.

The Potsdam in York county is seen to overlie the same schists near Wrightsville and York, near the former of which, as if to settle all doubt, two or three folds bring to the surface within a short distance all the measures above and below it. The Potsdam of Franklin county which lies upon the South mountain covers these same schists, and the very numerous varieties of clays and associated iron ores which are due to their decomposition.

The North Valley Hill quartzite in Sadsbury, Valley, East and West Brandywine, Upper and Lower Uwchlan, and other townships, is preceded and succeeded by gneissoid and chloritic mica schists, as seen at Atglen, Pomeroy,* Stottsville, Sadsburyville, north of Downingtown, on the Brandywine, north and south of Lionville, and at other places.

In this connection, the following, taken from the notes which were made by Mr. Hall and the writer, when, in September, 1876, they visited together Harper's Ferry, and made a section of the Potomac river in its vicinity, may not be without interest. It is necessary to premise that Mr. Hall holds the opinion, which is the natural deduction from his views of the horizon of the South Valley Hill schists, that the rock which the writer has designated "Mountain Creek Rock" from its occurrence in the part of the South mountain which is contiguous to this stream, is a representative of the Potsdam.

The exposure at the head of the bridge on the Maryland side, opposite Harper's Ferry, is of a great mass of this schistose rock with fragments of pink quartz, dipping S. 30° E.–45°. This continues for an horizontal distance of 1461 feet (445 meters) east and west of the bridge, along the Potomac river.

To the west there appears an hydro-mica schist, dipping S. 40° E.–18°, but curling so as to render it difficult to ascertain the true dip.

Further west are met in succession:

A
- Greenish chlorite slates.
- Hydro-mica slates very much convoluted.
- Hydro-mica slates.
- Chlorite slates dipping E. 20° S.–35°.

All the above have practically one dip.

* Stottsville, which is omitted from the geological map of Chester county, is on the southern side of the valley opposite Pomeroy.

B	Very compact dark blue slate S. 30° E.–26°.
	Same, with N. W. dip for a short distance.
	Same. Dip E. 30° S.–26°.
	Same. Dip N. 30° W.–24° (in ravine 300 ft. wide).
	Same. Dip E. 15° S.– ± 30°.
	Same. Much intersecting quartz.
	Same. Dip ± S. E. ± 40°.
	Same. Dip ± S. 35° E.–25°.
	Sandy slate, weathered nacreous schist E. 30° S.–20°.
	Iron ore clays.
	Limestone, with traces of fossils.

The horizontal distance covered by group A is 4341 feet, and by group B, 6060 feet.

It will not be easy to construct an inversion with these dips. It cannot be denied that *this* Mountain Creek rock lies on chlorite and hydro-micas, and, if there be no fault, according to Mr. Hall's theory, the fossiliferous limestone should lie about 3000 feet below these schists.

At 1029 feet east of the bridge the Mountain Creek rock, still dipping E. 25° S.–25°, is replaced by hydro-mica schist *as it were* by the gradual dying out of the fragments of quartz. The dip in the first part of these measures, which assumes the entirely changed form, is E. 30° S.–32°. This goes on alternating with quartzite and chlorite schists for 2700 feet, when a Mountain Creek rock comes in lying unconformably against the preceding. A repetition of the Mountain Creek rock commences from here, which is about 100 feet west of the first house* [*in 1876] of the settlement on the Maryland side of the river, opposite Harper's Ferry.

Chlorites, hydro-micas and quartzites therefore clearly lie above and in contact with the Potsdam if this be its representative.

(3.) "*But it is equally clear that the mica schists and gneisses are not found between the Primal and the rocks of the third belt.*"

This is, perhaps, equally clear with Proposition 2, but no more so.

As incidentally mentioned above, the whole structure of the east flank of the South mountain is opposed to this view. Here the schists lie on the central kernel or axis which, whether it be Laurentian or Huronian is, without doubt, older than the rocks we are discussing.

In Section 9, of Report CC, small synclinals of Potsdam are seen resting on the schists. In Section 7 of CC, four miles S. E. of Mt. Holly, the Potsdam (?) quartzite is seen overlying and underlying the chlorite slates.

At Chikis a belt of schists underlies the upper Potsdam quartzite and overlies the lower quartzite.

If the quartz rock of Peter's creek be the Potsdam, it lies on chlorite schists. So do the detached masses of Potsdam quartzite of North Codorus, Spring Garden, and Manheim townships in York.

The same is true of the Potsdam between Doe run and Toughkenamon, and in other places in South Chester and in Sadsbury, E. and W. Brandy-

wine (north of Downington), and Upper and Lower Uwchlan, north of the Valley.

As the premise is not admitted, neither can be the conclusion, which is, that:

(4.) *"If the mica schists were older than the Potsdam sandstone, they must have been deposited up to a geographical line which is sharply defined."*

It does not seem that this follows; but the suggestion about the geographical line opens the door at once to another explanation of which the grounds will be more fully stated presently.

This hypothesis is: That a fault line runs along the South Valley Hill, bringing up the lower pre-Potsdam schists and Laurentides. That this fault does not continue to the extreme eastern point of the synclinal, but leaves it near the eastern extremity, and pursues a course a little to the south of the latter, thus cutting off the southern extension of the Potsdam, but necessarily leaving a part of the northern sheet which, laid down unconformably on Laurentian and Huronian, has been subsequently eroded from the former except along the Bound Brook Branch R. R. This hypothesis is offered, with all modesty and reserve, simply from an inspection of Mr. Hall's map, and without personal study of the ground. But at least it seems possible that that which has happened to the limestone beds, when the fault passed through them, might happen to the enclosing Potsdam when its direction was through the latter.

(5.) *"Even supposing a fault which in all probability does exist along their northern edge, there would still be some remnants of these rocks to be found in their normal position upon the syenites of the Third Belt, and fragments of the rapidly disintegrating schists would have been entombed in the Potsdam sandstone itself, even supposing them to have been swept off the underlying rocks north of the present limit."*

It seems evident that the conditions are very different here from those which obtain in Chester and further west. The Susquehanna River section illustrates at Tocquan creek just the state of things spoken of here.

The axis of this great anticlinal where, without any doubt whatever, the lowest rocks on this river, within the limits of the State, are exposed, consists of a gneiss nucleus on which lie chloritic and hydro-mica, and finally (where Potsdam might be expected) *quartz* schists or schistose-quartz slates.

Mr. Hall's own definition of his "Edge Hill rock," too, would seem to render it unnecessary to cite examples elsewhere. He defines this rock, the type of his Potsdam, to be "*usually* a fine-grained white or gray sandstone and quartzite, *with scales of light-colored mica.* It is usually thinly laminated. *Occasional beds of fine conglomerate are met with.*" (p. 45.)

What better example of the entombed remains of the underlying schists could be expected? If the beds are thinly laminated, it is evident that the materials out of which they are composed were greatly broken up, and nothing would remain of the schists under the circumstances but the mi-

caceous minerals composing them, Mr. Hall does not state the nature of the fragments forming the conglomerate, but on page 46 the significant statement is made that, "Itacolumite *and hydro-mica schist* have been applied to the specimens analyzed."

There can be no error as to the rocks thus spoken of, as appears from six field numbers which are given of specimens of Potsdam analyzed, of which the first two are found on referring to the analyses to be "Itacolumite" and the last four "Hydro-mica schist." It will hence be unnecessary to multiply examples of the same kind which might be taken from any of the four counties enumerated above. The fact is indisputably established by Mr. Hall himself that remains of the schists are abundantly found in the Potsdam.

At this point the simple statement is made that the same difficulties are encountered in trying to find a place for the schists until the upper limit of the limestone is passed. As it is well known that there is an abundance of slates above this limit, the inference is drawn that the schists belong there.

This part of the discussion may be left with the remark that to the knowledge of the writer no extensive series of *chloritic* schists has been found to belong to the measures which are without dispute above the limestone of II.

A brief resumé of the principal reasons for assigning to these schists a lower horizon may be here roughly sketched:

(1.) There can be no doubt that the straight and narrow valley called the Chester Valley is connected actually with the great Lancaster limestone, and that it represents a part of a synclinal fold. The anticlinal once connecting it with the larger mass of limestone passed over (and probably high over) all of northern Chester county. If the schists to the south of the valley lie on the limestone, then the entire thickness of the latter must plunge beneath the surface within the limits of the valley. At places (as between Atglen and Pomeroy), the actual space which may be filled by limestone varies from a few hundred to fifteen hundred feet. But the limestone as measured on the Neffsville and Wrightsville sections is about 2700 feet thick. Of course if there be an upthrow on the south, any amount of the upper part of the limestone may have been eroded and any small portion of the lower beds left.

The dips are northward along the western part of Sadsbury township; and they are in sandy mica schist and gneiss on the north side [as for example N. 10° W.–30° (Atglen); N. 45° W.–10°; N.–50° (near Parkesburg); N. 45° W.–40° (ditto)]. The limestone when first found in place by the machine shops in Parkesburg strikes E. 25° N.– vertical. Further east near Pomeroy it is on the northern edge of the valley *N. 10° W.–50°*. Decomposed gneiss just north of Pomeroy gives a succession of S. E. dips about S. 10° E.–85°. A few hundred feet south of the north dip in the limestone is a dip ± S.–80°, and a thousand feet or so in the same direction S. 15° E.–60° etc.

North of the gneissoid schists again the quartzite dips about S. 15° E–45°, and therefore underlies these schists while the limestone either abuts upon them or overlies them in a sharp upward curve, which can no longer be traced.

(2.) The objection to the mathematical straightness of the line of junction of such soft rocks as the hydro-mica schists and the limestones is a serious one. Nothing is more likely, on the other hand, than that such a mathematical line of demarcation should be established by a line of fracture.

(3) The absence of limestone from the junction of the Potsdam and the schists from Huntingdon Valley eastward on Mr. Hall's map, is difficult to explain if these schists really belong above the limestone, and there be no fault along this line. If on the other hand there be a fault (which naturally extends along the South Valley Hill), it is singular that it does not bring up the underlying limestone and broaden that valley if the schists of the South Valley Hill are superior to the limestone.

(4.) The limestone of Adams, York and Lancaster counties believed to be No. II of Rogers is much mixed with schistose and micaceous matter in its inferior layers and is usually surrounded by schists from which this foreign matter is derived.

The limestone of Chester county, near Stottsville, Pomeroy, Parkesburg, and for the whole length of the Chester Valley, is similarly mixed with micaceous matter and frequently resembles a mica schist more than a limestone.

(5.) The Potsdam quartzite and sandstone near Coatesville are similarly mixed with micaceous material, and this texture may be very frequently observed in the lower layers of the Potsdam elsewhere in Chester as well as where Mr. Hall has observed it.

(6.) The contact of the limestone sometimes with the Potsdam and sometimes, when the latter is absent, with the schists, may be observed in lower Lancaster and apparently on the southern side of the great (Tocquan?) anticlinal which passes through Sadsbury townships of Chester and Lancaster counties.

(7.) In various places in East and West Brandywine and Lower Uwchlan, chlorite and hydro-mica schists are abundant below the Potsdam. The series is well exposed from a short distance north of the E. Caln border on the North Branch of the Brandywine past Dowlin's Forge and Dorlan's Mills.

(8.) If the schists south of the Chester Valley be younger than the limestone, and the Doe Run and Chester Valley limestones represent but one horizon, there must be a synclinal fold between the two.

But it has been stated above that the dips are flatter towards the south, so that if there be here a plication, it is an anticlinal.

(9.) There should be evidence of Potsdam south of the belt of limestones striking with that of Doe Run to the east, but there is not.

(10.) There should be evidence that the Doe Run limestone is above the Potsdam to the south, but the former appears to dip under the latter.

This limestone as well as the small detached bodies just alluded to seem to be analogous to that between Scottsville and Rockville in Bucks county.

(11.) There are small tongues and isolated patches of Laurentian rocks occurring in the midst of these southern schists. One comes into Chester county from the east in Eastown and Treddyfrin townships, and another occupies a small area near West Chester. These patches are bordered on all their sides by these schists with no intervening rocks. The bordering rocks therefore cannot belong to a group above the Potsdam and the lower Silurian limestone.

(12.) Several localities in Kennett Square and New Garden townships exhibit areas of Potsdam rocks surrounded by these schists with no intervening limestone. The schists therefore cannot belong to an horizon superior to the latter.

These are some of the reasons which are opposed to the structure suggested by Mr. Hall.

The section on Mr. Hall's p. 32 is so different from the same section which the writer made in 1880, and the conclusions which Mr. Hall draws from his section, are so important, that a rough copy of the writer's section is herewith subjoined, on an approximate scale of 1425 feet = 1 inch. The direction of the section is about that of the average dip or S. 12° E. It is necessary to explain that the first group of dips is projected on the line of section at Henderson's Station from the road west of that point, and the Primal must lie west of where this section begins.

If this junction be accepted, however, from Mr. Hall's observations, it will not affect the important conclusions which suggest themselves. First, of a possible fault between the limestone with part of its underlying schists and the mica-schists to the S E.; and secondly the synclinal character of the limestone near Conshohocken, with an anticlinal of the underlying schists to the south-east cut by a trap dyke.

N. 19° W.

Scale about 1425 ft. to 1 inch.

S. 19° E.

Mechanicsville.

Henderson's Station.

Fault (?)

Mica Schist, Hydro-mica schist and Gneiss.

Limestone.

Trap.

Gneiss.

?

Marble S. 10° E.–67°.

Mica Schist S. 20° E.–62°.

Clay and Mica Schist fragm.

Fault (?)

Mica Schist N. 28° W.–50°.

Mica Schist and hydro-mica schist

Summit of Ridge.

Mica Schist S. 10° E.–50°.

Mica Schist and rotten gneiss frgs.

Mica Schist and gneiss frgs.

Limestone S. 20° E.–85°.

Limestone S. 15° E.–80°.

Limestone S. 15° E.–85°.

Gneiss { S. 15° E –85°. / S. 25° E.–45°.

Trap Conshohocken.

Obituary Notice of Edouard Desor. By J. P. Lesley.

(*Read before the American Philosophical Society, May 19, 1882.*)

The winter of 1881–2 will be remembered for the great losses which the world of culture suffered in rapid succession: Draper, Longfellow, Emerson, in America; Darwin and Desor in Europe. Other names, also, were erased from the roll of the world's prophets; but these were teachers of the prophets—primates and patriarchs in the hierarchy—masters on whom others depended, and to whom they deferred—leaders in the procession of thought and expression of thought—founders of styles and methods—builders of superior edifices of human knowledge and human taste; characterizing the century in an active as well as a passive mood, and therefore leaving Christendom in mourning for their disappearance.

The world remarks that these men were much beloved. They were gentle, loving beings, as amiable as they were vigorous of soul. That the world loved them and heard them gladly proves that the world is better than it was. That they could sing, and think, and work, without molestation, proves that the world is wiser than it was. The powers hostile to human enlightenment have lost their thrones; personal liberty is established. The tribune and the press are, the pulpit is becoming, enfranchised. And as with personal liberty a higher tone of private morals has supervened, so with liberty of speech and pen has come into the life of Christendom a gentler spirit of controversy and a more judicial method of investigation. Fear is the mother of cruelty and its brood of vices intellectual and physical. Persecution has always bred heresy. The excommunicated hate the excommunicators; exiles are emancipated from all respect and affection for government. The suppression of ideas by physical force is like the compression of explosives; times are always coming to apply the match or pull the trigger. Men who are forced to fly from their ancestral homes to begin a new career elsewhere, acquire rapidly by the struggle for life a noble development of all their powers; gaze upon the new world around them with new eyes; inform themselves of what would never have interested them; ally themselves with the strongest and wisest whom they find; invent enterprises; place scaling ladders against the ramparts of fame, and in the end come to be of the number of the world's rulers.

Such was the experience of the man whom, as a member of this Society, we remember and lament, Edouard Desor of Neufchâtel.

The Desors were Huguenots expelled from France by the revocation of the edict of Nantes. They settled in Hesse-Homburg, and helped to form there a little colony which retained in use the French language in their dwellings, schools and churches, while it adopted the German language for intercourse with the world around.

In 1811 (Feb. 13th) our late distinguished fellow-member Edouard Desor was born at Friedrichsdorf near Frankford-on-the-Main. He was

baptized Pierre Jean Edouard, but his publications and his literary correspondence show that he had dropped the first two names, and few persons were aware of his having any other personal designation than Edward.

His father's name was Jean Desor, and his mother's maiden name was Christine Albertine Foucar.

"Desor" was originally "Des Horts," meaning "of the gardens." A Catholic branch of the family Des Horts still reside at Marsillargues, in the south of France, on the route from Lunel to Aigues-Mortes. From this little village many Protestant families were chased into exile, by Louis XIV, in 1685. M. Fritz Berthoud in his "L'Hiver au Soleil," describes how, in one of their journeys to the Mediterranean coast, Desor and he stopped to make the acquaintance of this scene of persecution.

Jean Desor, at Friedrichsdorf, conducted one of those manufactures which France lost by the folly of her so-called Great Monarch. He died and left his two boys to the care of their mother; but she, too, worn out with misery and loneliness, died, and they grew up as best they could.

Young Desor's education was, however, on the whole a good one; and the peculiar constitution of his native town gave him this advantage: French and German were alike his mother-tongue. This made it easy for him, when the time came, to lead a useful life in Paris, and to settle finally at Neufchâtel, where both languages are spoken alike by all.

He acquired a good knowledge of English, also. Several years of residence in the United States made our language as familiar to his ear and tongue as his own native dialects. Although he never overcame the difficulty of pronouncing such sounds as *th*, and always spoke of *sick* and *sin* rocks, he nevertheless wrote English in a singularly pure style, and spoke it with admirable precision and force. His long intercourse with Italian geologists and his frequent residences in Italy gave him command of the Italian language.

His earlier education was gained at the gymnasium in Hanau. Thence he was transferred to the University of Giessen, and commenced his studies for the legal profession, which he afterwards continued at the University of Heidelberg. His elder brother adopted the career of a physician.

At Giessen also was educated Desor's colleague in science and life-long bosom friend, Karl Vogt, who was six years his junior, and who still survives to mourn his loss. Vogt afterwards studied chemistry with Liebig at Heidelberg, and (1835) anatomy and physiology with Valentin at Berne, when Desor was already established with Elie de Beaumont in Paris.

As his forefathers had been persecuted out of France into Germany for their religious and political heresies, so Desor and his brother were driven back from Germany into France by persecution, on account of their enthusiastic sympathy with the revolutionary excitement of 1830, which pervaded all Europe, the principles of which were elaborated in the universities of Germany, and preached and practised by the entire burschen-

schaft, inflamed with vague hopes of a repetition of the French revolution, the destruction of irresponsible princedoms, and the liberation and unification of the Fatherland. Vogt fled to Switzerland. Desor's brother, after a short stay in Paris, settled also in Switzerland, at Neufchâtel, although that canton was an appanage of Prussia, and its inhabitants spoke French and German indifferently. But Desor himself remained in Paris from 1832 onwards until his brother's marriage to a wealthy lady, M'lle de Pierre, in Bôle-over-Colombier, proved too strong an attraction, and he became a Swiss, not only in residence, but in heart and soul and character, and remained a Swiss to the last day of his life.

In Paris he tried at first to support himself by translating, for a French publisher, Ritter's Erdkunde. He was also employed by Dr. Hahnemann as his private secretary. I have heard him affirm of his own knowledge that the transfer of simple homœopathy on to the trancendental ground of infinitesimal doses, with correspondingly high powers, was the work of Madame Hahnemann; her husband having nothing to do with it.

In Paris, Desor studied geology under Elie de Beaumont who, then 34 years old, had become Professor of Geology in the College of France in 1832 the year of Desor's expatriation.

This year of 1832 is famous in the history of our science, for it marks best the date of the labors of Sedgewick and Murchison in England and Wales. It was also the year of the cholera. In 1833 Elie de Beaumont was made Chief Engineer of Mines; and with Dufrenoy commenced the preparation of the great geological map of France, published in 1841. His Mountain Systems did not appear until 1852; but during the interval of 20 years he was elaborating that masterpiece of geological genius in lectures which raised him to the pinnacle on which he stood until his death as the greatest living geologist, while it overthrew the factitious reputation of his great popular rival Leopold von Buch.

Desor, however, was not much influenced by the special views of his great master regarding the structure of the earth, and was too much influenced by the vague notions of the Swiss geologist Thurman, who tried to apply a modification of Von Buch's elevation theory to the anticlinals of the Jura. Nor is it strange that Desor, only 21 years old, should not have been more influenced by Elie de Beaumont's peculiar structural theories. It cannot be otherwise, however, than that his subsequent devotion to geology was born in him by the teaching of his great master. In after years he threw himself with ardor into orographic research; but it was always more practical than speculative; and the extensive orographic studies which he continued at intervals until his death were probably mainly due to his experiences on the glacier of the Aar. His memoirs on the Massifs of the Alps are inspired by quite a different motive from that which impelled Elie de Beaumont to the construction of his crystalline globe. For Desor the structure of valleys through which descended his glaciers was the main thing! The surface, and not the underground, held

his attention. His systematization of Alpine ranges is wholly topographical; not at all mineralogical, much less plutonic. In my many conversations with him I heard no theory escape his lips which went deeper than the erosion of the surface, nor was Elie de Beaumont ever alluded to. His orography was essentially systematic and descriptive.

He accompanied Elie de Beaumont to the meeting of the Helvetic Society, at Neufchâtel, in 1837, and there became acquainted with Agassiz; and this became the turning point of his intellectual life. But the first result of the influence which Agassiz exerted over him was hostile to any train of thought suggested to him by Elie de Beaumont. It drew him first into the study of the fossil forms in the rocks of the Jura Mountains, and then into the study of the glaciers of the Alps. It was not until Desor joined the corps of Pennsylvania geologists, in 1852, that his eyes were really opened to the wonderful phenomena which had long before inspired the genius of Elie de Beaumont to reconstruct the fundamental axioms of structural geology. In fact, the bent of Desor's mind was for investigating the forms and habits and metamorphoses of the animal world; and the large way in which he afterwards pursued these studies was due not to the instructions of Elie de Beaumont in Paris, but to the influence of the superior genius of Louis Agassiz in Neufchâtel, and through Agassiz of that coryphæus of modern science, Agassiz's great master, Cuvier.

After his return from America to Switzerland Desor studied the structure of the Jura Mountains with a clearer vision; but, while his definition of structural forms was singularly precise and complete, his theoretical conclusions were always based on more violent hypotheses than those in vogue in the school of Lyell. He remained to his last days a moderate cataclysmist both as to plication and as to erosion.

After leaving Paris to take up his permanent residence in Switzerland Desor lived for a short time in the house of Professor Vogt, the father of Karl Vogt, in Berne. At one of the annual reunions of the Helvetic Society of Natural Sciences Vogt introduced Desor to Agassiz, who induced him to settle in Neufchâtel. Agassiz, born in 1807, was only 4 years older than Desor, and they soon established a close brotherhood in society and science, which lasted nearly twenty years. Agassiz had studied medicine at Zurich, Heidelberg and Munich; but by a curious accident, which he was fond of narrating, his residence in the same house with an old man whose rooms were filled with preparations of fish, Agassiz became enamored of that special branch of Natural History; had studied the fish brought from Brazil by Martius & Spix, and published his Latin description of them in 1829–31; and was appointed Professor of Natural History at Neufchâtel in 1832, where he was now in the full tide of his researches into the nature and distribution of fossil fish. It was during a visit to Paris that Agassiz made friends with Cuvier and Humboldt; and at Paris his great work on the Classification of Fish went through the press during the ten years from 1832 to 1842.

The summer vacations of Agassiz were spent on the glacier of the Aar.

him the communication, description, or model, except the officer to whom it shall be entrusted; nor shall such officer part with the same out of his custody, without a special order of the Society for that purpose.

6. The Society, having previously referred the several communications from candidates for the premium, then depending, to the consideration of the twelve counsellors and other offices of the Society, and having received their report thereon, shall, at one of their stated meetings in the month of December, annually, after the expiration of this current year (of the time and place, together with the particular occasion of which meeting due notice shall be previously given, by public advertisement) proceed to final adjudication of the said premium; and, after due consideration had, a vote shall first be taken on this question, viz.: Whether any of the communications then under inspection be worthy of the proposed premium? If this question be determined in the negative, the whole business shall be deferred till another year; but if in the affirmative, the Society shall proceed to determine by ballot, given by the members at large, the discovery, invention or improvement most useful and worthy; and that discovery, invention, or improvement which shall be found to have a majority of concurring votes in its favor shall be successful; and then, and not till then, the sealed letter accompanying the crowned performance shall be opened, and the name of the author announced as the person entitled to the said premium.

7. No member of the Society who is a candidate for the premium then depending, or who hath not previously declared to the Society, that he has considered and weighed, according to the best of his judgment, the comparative merits of the several claims then under consideration, shall sit in judgment, or give his vote in awarding the said premium.

8. A full account of the crowned subject shall be published by the Society, as soon as may be after the adjudication, either in a separate publication, or in the next succeeding volume of their Transactions, or in both.

9. The unsuccessful performances shall remain under consideration, and their authors be considered as candidates for the premium for five years next succeeding the time of their presentment; except such performances as their authors may, in the meantime, think fit to withdraw. And the Society shall annually publish an abstract of the titles, object, or subject matter of the communications, so under consideration; such only excepted as the Society shall think not worthy of public notice.

10. The letters containing the names of authors whose performances shall be rejected, or which shall be found unsuccessful after a trial of five years, shall be burnt before the Society, without breaking the seals.

11. In case there should be a failure, in any year, of any communication worthy of the proposed premium, there will then be two premiums to be awarded the next year. But no accumulation of premiums shall entitle the author to more than one premium for any one discovery, invention or improvement.

12. The premium shall consist of an oval plate of solid standard gold of the value of ten guineas. On one side thereof shall be neatly engraved a

short Latin motto suited to the occasion, together with the words: "The Premium of John Hyacinth de Magellan, of London, established in the year 1786;" and on the other side of the plate shall be engraved these words: "Awarded by the A. P. S. for the discovery of ——— A.D.———" And the seal of the Society shall be annexed to the medal by a ribbon passing through a small hole at the lower edge thereof.

SECTION 2. The Magellanic fund of two hundred guineas shall be considered as ten hundred and fifty dollars, and shall be invested separately from other funds belonging to or under the care of the Society, and a separate and distinct account of it shall be kept by the treasurer.

The said fund shall be credited with the sum of one hundred dollars, to represent the two premiums for which the Society is now liable.

The treasurer shall credit the said fund with the interest received on the investment thereof, and, if any surplus of said interest shall remain after providing for the premiums which may then be demandable, said surplus shall be used by the Society for making publication of the terms of the said premium, and for the addition, to the said premium, of such amount as the Society may from time to time think suitable, or for the institution of other premiums.

The treasurer shall, at the first stated meeting of the Society in the month of December annually, make a report of the state of said fund and of the investment thereof.